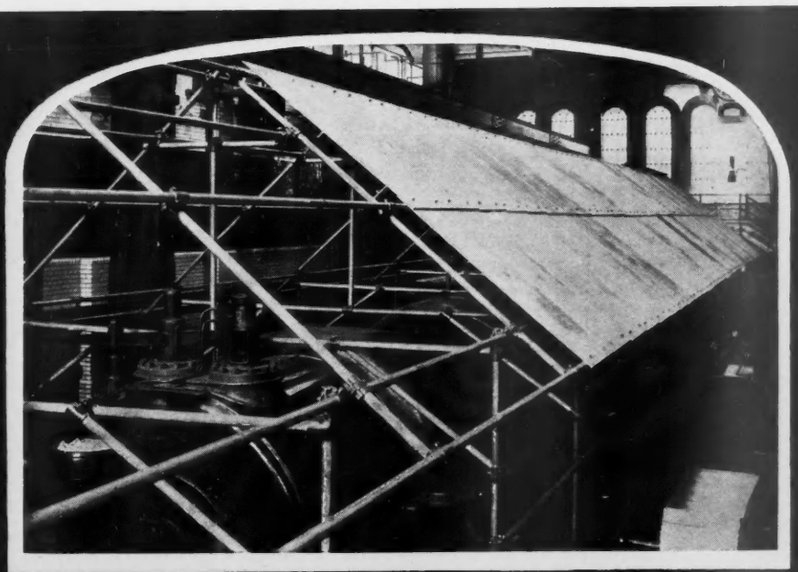
Supplement to "The Builder," February 24, 1939.

THE BUILDER
a Journal for the
ARCHITECT & CONSTRUCTOR

STRUCTURAL PRECAUTIONS

against

AIR ATTACK—2.



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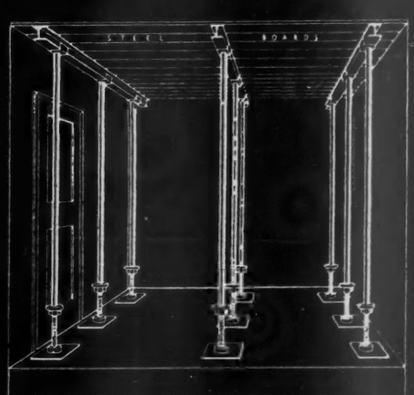

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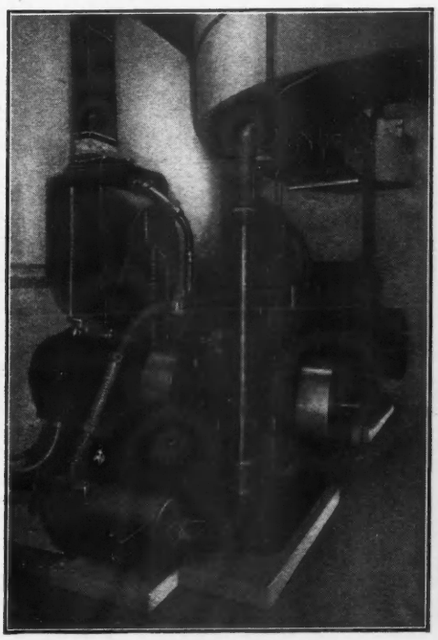
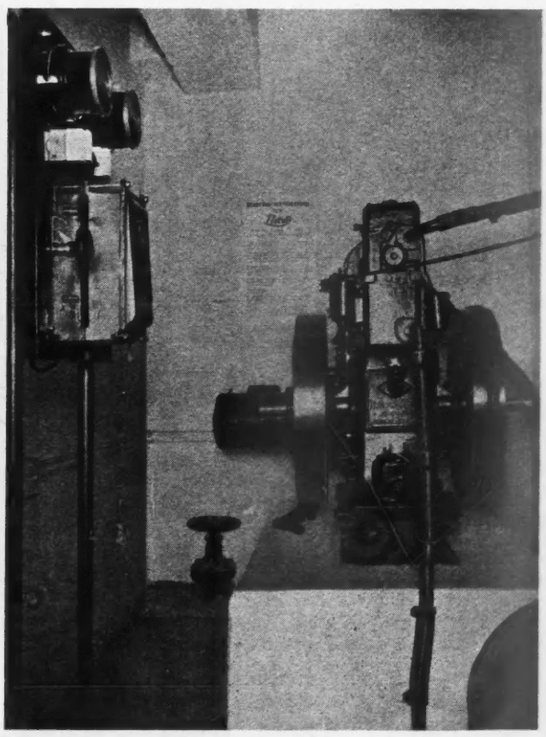


Photo The Oil Engine



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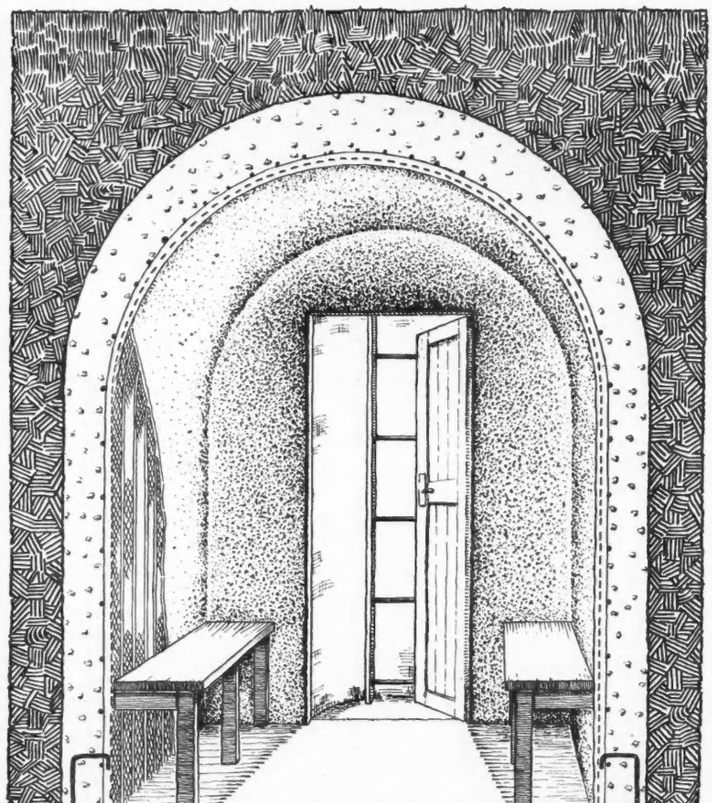

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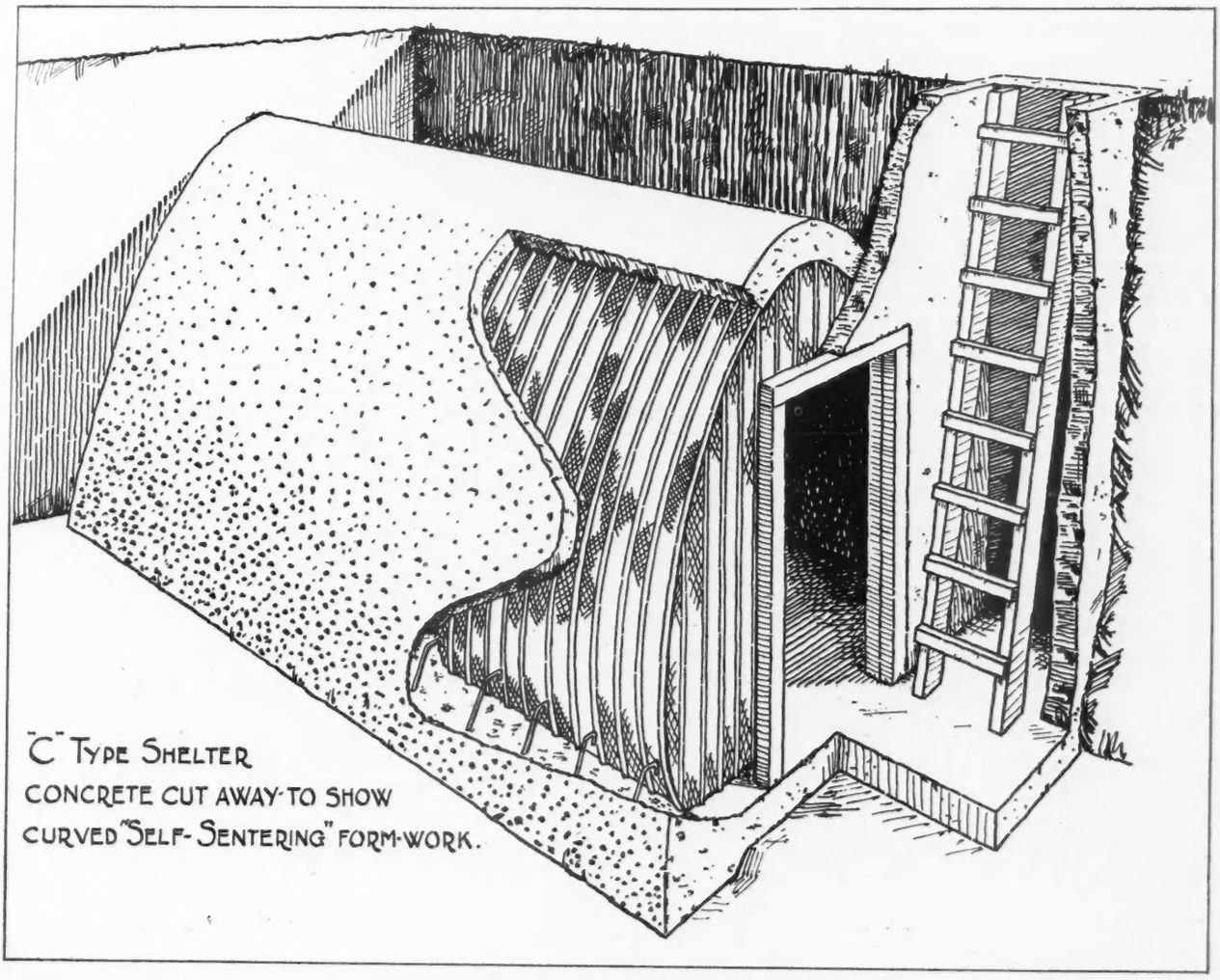

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THE BUILDER
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STRUCTURAL PRECAUTIONS *against* AIR ATTACK—2.

Partial Protection?

An analysis of some of the factors affecting the efficiency of Air Raid Shelters.

By Oscar A. Bayne, A.R.I.B.A.,
in collaboration with Conrad W. Hamann, Consulting Engineer.

IT is already widely appreciated that A.R.P. as it affects the building industry falls into two clearly defined sections:

I. The protection of the individual.
II. The protection of property.

The second part of the subject is in reality a matter of so designing buildings that they will *resist damage* from air attack more effectively than those which have been erected in the past; it may or may not include the provision of special protected accommodation for the occupants.

While the application of A.R.P. principles to the design and construction of new buildings is an important matter, it is difficult to understand why it has been given the predominant place it now occupies in architectural circles.

The question of shelter design is in reality far more important, far more urgent and far more difficult; moreover, it is a problem which must be solved before building precautions can be properly designed. Obviously, until the whole subject of shelter design has been examined and a general method and some standards of protection have been adopted, the question of whether shelters should be provided in buildings cannot be answered; and, of course, the application of A.R.P. principles to new buildings is seriously affected if the buildings are intended to protect the occupants.

That some agreed basis for shelter design is urgently needed is illustrated by the fact that architects are now designing, for the same purpose and to meet roughly the same conditions, shelters which vary from timber-lined trenches to structures with specially reinforced concrete walls and roofs several feet thick; a state of affairs which, to say the least, is staggering and cannot in the long run reflect much credit on individual architects or the profession as a whole.

The conditions affecting shelter design are so vague and the objects so ill-appreciated that we have on the one hand many in the profession who believe that nothing less than bomb-proof refuges are adequate; and, on the other, many who, perhaps a little complacently, say: "But nothing is bomb-proof so we need only bother about blast and splinters"; and we have, unfortunately, those who can say: "When our clients ask 'for a little bit of A.R.P. that won't cost too much,' we've got to give it to them."

It is generally accepted that in certain vital areas particularly liable to concentrated attack, bomb-proof shelters are essential; similarly it may be argued that in certain farm districts the few inhabitants will require little shelter because of the remoteness of the likelihood of attack and low density of population—two farm labourers in a hundred-acre field would be difficult bombing targets even if they only scooped themselves shallow troughs to lie in. In between these extremes there must be some justification for gradation in protective value.

Admittedly, once we have forsaken the bomb-proof protection we have introduced an element of risk—that of a direct hit by a bomb of sufficient size to destroy the shelter. This element of risk is affected principally by two factors:—

(*a*) The degree of protection provided by the shelter.
(*b*) The likelihood of a direct hit if the area is attacked.

The protection offered by the shelter can be related to the destructive capacity of certain known bombs, but the likelihood of attack in any given area could probably only be guessed at even by the military strategist; no one can tell how far the enemy will prefer to attack the well-defended vital centre to the ill-defended or defenceless, less vital area. The general principle that civil populations are worth attacking has, however, been firmly established in recent years, and we must, therefore, accept the proposition that any community is liable to attack if it is large enough to present an effective target and is in an accessible district.

It is often assumed that particular districts are unlikely to be attacked, and that, therefore, a minimum of protection may be provided, but this proposition does not seem to be well founded, for two reasons: because protection, if in fact it is not effective *when the area is attacked*, might just as well not have been provided at all, and because it is not unjustifiable to assume that any attack will in itself be of some intensity; it may be over a limited area, but nevertheless the explosive will be just as effective as in a more intense attack.

Some towns will no doubt be subjected to continual raids, others to infrequent visits. Apart from vital centres, such as centres of organisation, munitions works, etc., the general scale by which any given area may be valued as a target is that of density of population. Obviously, more result will be obtained per bomb in a

densely built-up and densely populated area than in a less congested one.

The density of population also appears to determine to a large extent the value of shelter accommodation (unless it is bomb-proof accommodation). The density of population determines the density of shelters; if the number of shelters is great and the proportion of ground area occupied by them is high, then the chances of a considerable number of them being hit are high. Conversely, if shelters are few and small, the chances of a direct hit are correspondingly small.

This variation in risk obtains (within certain limits) irrespective of the degree of protection offered by the shelter construction.

Shelter Design: Relation to Risk Involved.

In the following notes an attempt has been made to relate shelter design to the risk involved, *i.e.*, to the chance of shelters being hit.

The vital factor in all shelters offering only partial protection is the value of protection offered, not only because of the resistance of the walls and roof to a direct hit, but because the greater the strength of the construction the smaller will be the vulnerable area surrounding each shelter. The size of the vulnerable area and the number of shelters in any given district govern the chances of an effective hit. Obviously if the whole district is occupied by shelters, then every bomb must score a direct hit.

No account has been taken of the liability of the occupants of shelters to suffer from concussion, because as yet no reliable information is available. It may be that the allowance which has been made for the vulnerable area around a shelter is not large enough, particularly in the case of the larger bombs.

Population and Density.

The basis on which the figures are given in the following tables may be summarised as follows:

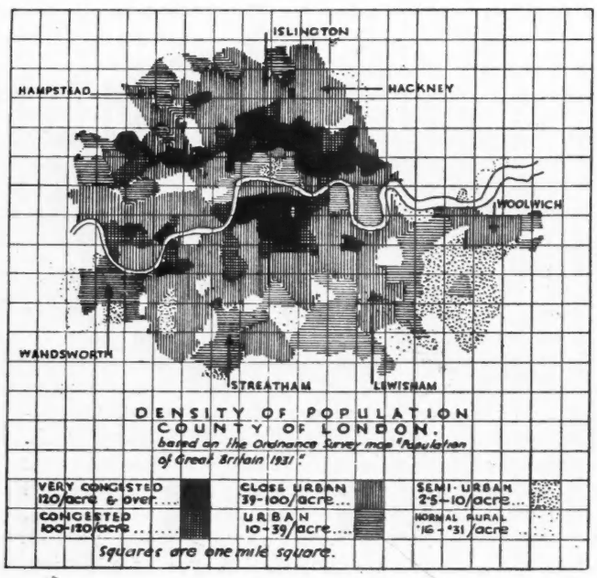
The Ordnance Survey map entitled "Population of Great Britain, 1931," gives amongst others the following designations and sub-divisions for the density of population:

Transitional	400– 1,600	persons per sq.mile	(.625–2.5	per acre)
Semi-urban	1,600– 6,400	,, ,, ,,	(2.5–10	,,)
Urban	... 6,400–25,000	,, ,, ,,	(10–39	,,)
Close urban	25,000–64,000	,, ,, ,,	(39–100	,,)

The lowest group given is "occasional" (0 to 1 persons per square mile), and the highest is "very congested" (76,800 persons per square mile and over).

The densities of population used below are based upon the Ordnance map entitled "Population of Greater London." The grouping of population-density given on this map which roughly corresponds to those above is:

.16 to 1.5	per acre, for which the average figure of			0.84	has been taken for use below.	
1.5 to 7.5	,,	,,	,,	4.5	,,	,,
7.5 to 17.5	,,	,,	,,	12.5	,,	,,
17.5 to 30	,,	,,	,,	24	,,	,,
30 to 55	,,	,,	,,	42.5	,,	,,
55 to 85	,,	,,	,,	70	,,	,,
85 to 110	,,	,,	,,	97.5	,,	,,



Diag 1.

Shelters.

Three general types of shelters have been taken, type A being of the kind at present being produced by the Government. The steel shell has been assumed to be partially sunk into the ground and protected with sand bags or earth cover to equal the strength recommended by the Home Office, *i.e.*, capable of resisting the effects of blast, fragmentation and flying missiles from a 500 lb. bomb bursting 50 ft. away. (Diag. 2.)

The figures of 24 ft. and 33 ft., taken for 112 lb. and 224 lb. bombs, respectively, have been taken in proportion from the Home Office figures for 500 lb. bombs (50 ft.) by analogy, from the formulæ given in the Memorandum on Blast issued by the Institution of Civil Engineers, which applies to explosive zones.

It has been assumed that blast and splinter effects would follow the same general laws as apply to the explosive zone, because in each case the source of energy is the same, and the dissipation of energy takes place in three dimensions in both cases.

The second shelter, type B, is the same steel shell sunk into the ground entirely with an earth cover of 2 ft. 6 in. above. Allowance has been made for additional space at one end for access. No exact information appears to be available to architects on the intensity of the shock wave from an explosion or its transmission through earth or concrete. (Diag. 3.)

Two guiding statements have, however, been made: "The heavy armour-piercing or semi-armour-piercing bomb will penetrate into about 6 ft. of concrete before exploding, and will require another 10 ft. of reinforced concrete to resist the downward blast effect."

Referring to bomb penetration in the chalk of Epsom Downs, Colonel Garforth said: "A bomb would bore into the chalk about 30 ft., and the pressure pulse would continue for about 20 ft. to 30 ft."

While there are not sufficient data available on which to base exact figures, it is clear that, apart from the effects of shock and concussion on the occupants, some allowance must be made either for an adequate thickness of earth between the explosion and the shelter to absorb the shock wave, or for adequate strength in the structure of the shelter itself to enable it to resist collapse owing to the shock wave.

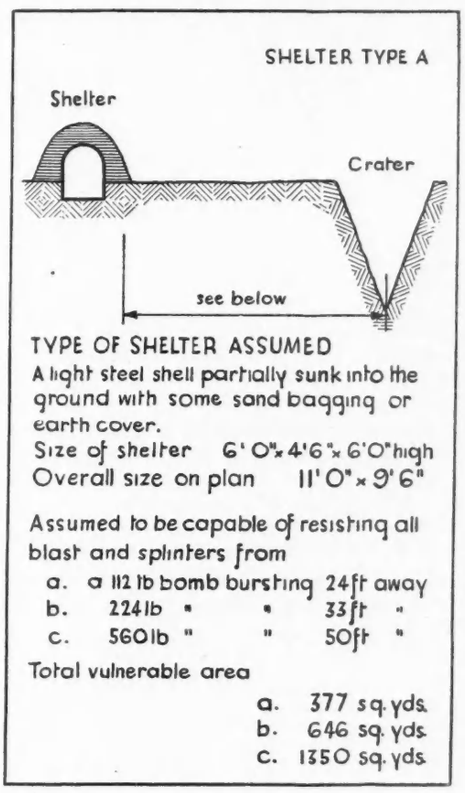
For the purpose of these calculations, it has been assumed that the light steel shell has not sufficient structure strength to resist damage by the shock wave from a—

112 lb. bomb bursting less than 12 ft. 6 in. away.
224 lb. bomb bursting less than 16 ft. 6 in. away.
560 lb. bomb bursting less than 25 ft. away.

The type C shelter has been assumed to be capable of resisting a direct hit on its roof from both 112 lb. and 224 lb. bombs. This pre-supposes that the shelter is either of very heavy construction or is protected by a considerable depth of earth cover. The depth of the shelter below the ground taken in conjunction with the strength of the structure will determine the vulnerability of the structure to earth shock. (Diag 4.)

For the present purpose, it has been assumed that the shelter is at such a depth or is sufficiently strong to resist the shock wave from a 560 lb. bomb bursting 12 ft. away. Since this type of shelter would be very

expensive *per person*, if it housed only the four persons allowed for the Government type of steel shelter, the example used here has been taken as twice the size internally, and of twice the capacity (eight persons).


SHELTER TYPE A
Shelter
Crater
see below
TYPE OF SHELTER ASSUMED
A light steel shell partially sunk into the ground with some sand bagging or earth cover.
Size of shelter 6'0" x 4'6" x 6'0" high
Overall size on plan 11'0" x 9'6"
Assumed to be capable of resisting all blast and splinters from
a. a 112 lb bomb bursting 24ft away
b. 224lb " " 33ft "
c. 560lb " " 50ft "
Total vulnerable area
a. 377 sq. yds.
b. 646 sq. yds.
c. 1350 sq. yds.

Diag. 2.

The figures given in the following Table (I) set out the total plan-area of the shelters required for a district of one square mile for various densities of population. The vulnerable area surrounding each shelter has been included in the plan-area and the total area of all the shelters thus obtained has been compared with the area of one square mile.

The ratio of plan-area of shelter to the total area of the district (1 sq. mile) is a measure of the chances of some shelter or shelters being hit. It should be made clear here that the chances of any one particular shelter "X" being hit remain constant, irrespective of the density of population or the number of shelters, but the chances of some unspecified shelter being hit rise directly with an increase in the total area of shelters.

The ratio of areas is then related to the effect of one ton of bombs. If, as is the case in the first column of figures, the area ratio is 1 : 61, then one bomb in every 61 dropped is likely to damage a shelter ; since there are 20 one-cwt. bombs per ton, the number of shelters likely to be damaged per ton of bombs dropped is in this case :

$$1/61 \times 20 \qquad 0.32 \text{ shelters.}$$

Since each shelter houses four persons, 1.3 persons are involved per ton of bombs in this area of low density.

In the column on the right-hand side the figures for a population density of 97.5 persons per acre show that 37.7 shelters and 157 persons are involved per ton of bombs dropped.

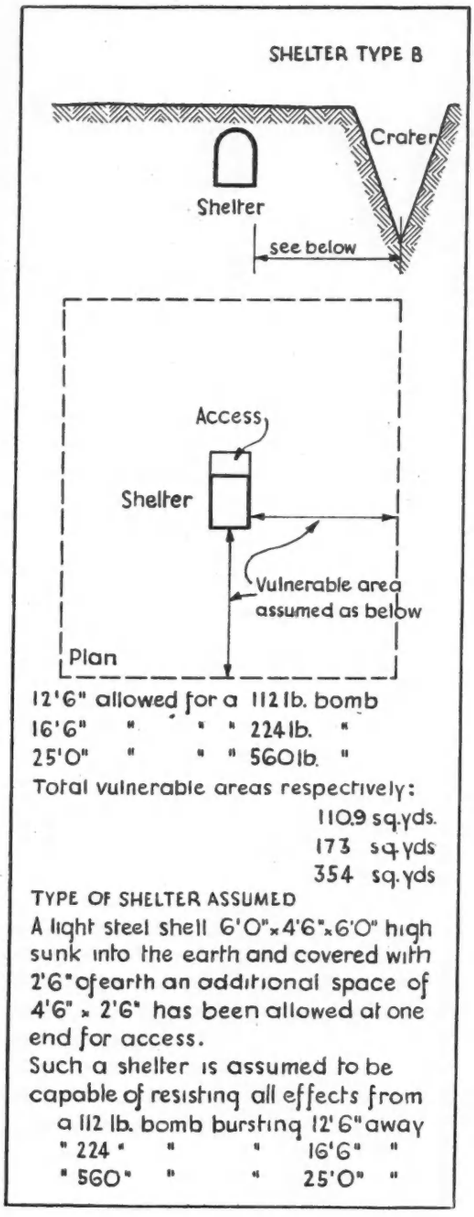
Since, say, 100 tons of bombs could be carried by 40 or 50 planes in one attack, it will be seen that the figures represent a high rate of death and wounding, particularly as the density of population rises.

It will be seen that with a type of shelter which is vulnerable to all three sizes of bomb, although the ratio of areas is more favourable for the smaller bombs, the lighter bombs are more effective per ton because there are more of them.

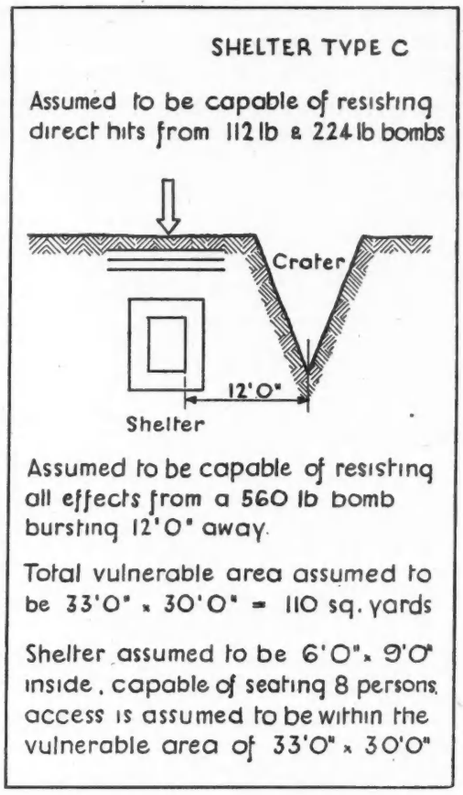
TABLE I.

TYPE OF SHELTER. A. LIGHT SHELL, PARTIALLY ABOVE GROUND, BUT EARTH-COVERED OR SANDBAGGED. See above.

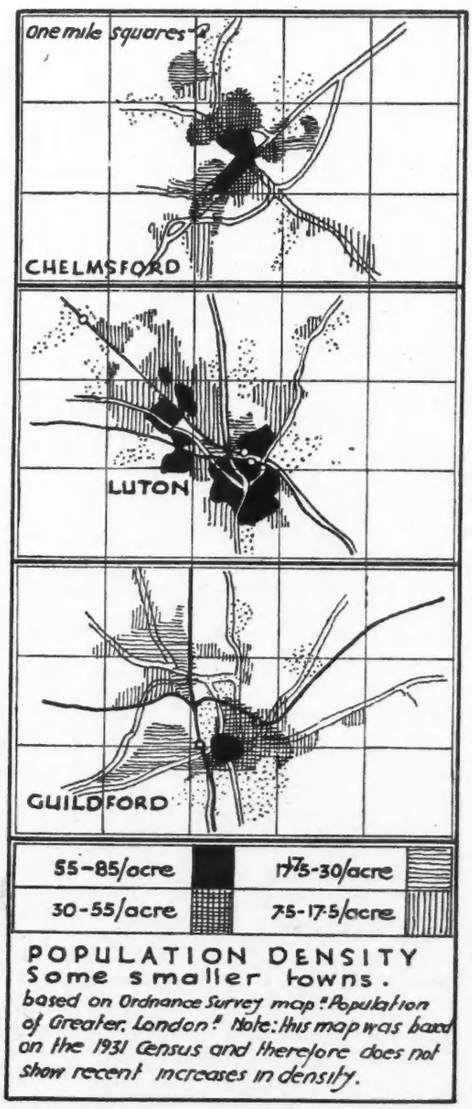
Population—Per acre	0.84	4.5	12.5	24	42.5	70	97.5
Per sq. mile ...	540	2,880	8,000	15,360	27,200	44,800	62,400
Number of shelters required (see above)	135	720	2,000	3,840	6,800	11,200	15,600
112 LB. BOMBS (1 CWT. or 51 KILOS).							
Total plan-area of shelters plus vulnerable areas (as above 377 sq. yds. each)	50,950	271,600	754,000	1,448,000	2,562,000	4,220,000	5,880,000
Ratio of shelter area to total area	1 : 61	1 : 11.4	1 : 4.1	1 : 2.14	1 : 1.2	1 : 0.73	1 : 0.53
Number of shelters damaged per ton of bombs (20 bombs)	0.32	1.7	4.9	9.3	16.8	27.4	37.7
Number of occupants involved	1.3	7	20	37	67	110	151
224 LB. BOMBS (2 CWT. OR 103 KILOS).							
Total plan area of shelters plus vulnerable areas (as above 646 sq. yds. each)	87,200	465,000	1,293,000	2,480,000	4,440,000	7,250,000	10,090,000
Ratio of shelter area to total area	1 : 35.4	1 : 6.65	1 : 2.49	1 : 1.25	1 : 0.7	1 : 0.43	1 : 0.31
Number of shelters damaged per ton of bombs (10 bombs)	0.28	1.5	4.2	8.0	14.3	23.3	32.3
Number of occupants involved	1.1	6	17	32	57	93	129
560 LB. BOMBS (5 CWT. OR 254 KILOS).							
Total plan area of shelters plus vulnerable areas (as above 1,350 sq. yds. each)	182,250	972,000	2,700,000	5,184,000	9,190,000	15,100,000	21,050,000
Ratio of shelter area to total area	1 : 17	1 : 3.18	1 : 1.10	1 : 0.6	1 : 0.34	1 : 0.21	1 : 0.15
Number of shelters likely to be damaged per ton of bombs (4 bombs)	0.23	1.2	3.6	6.7	11.8	19	26.6
Number of occupants involved	0.92	4.8	14.4	27	47	76	106


SHELTER TYPE B
Crater
Shelter
see below
Access
Shelter
Vulnerable area assumed as below
Plan
12'6" allowed for a 112 lb. bomb
16'6" " " " 224 lb. "
25'0" " " " 560 lb. "
Total vulnerable areas respectively:
110.9 sq.yds.
173 sq.yds
354 sq.yds
TYPE OF SHELTER ASSUMED
A light steel shell 6'0"×4'6"×6'0" high sunk into the earth and covered with 2'6" of earth an additional space of 4'6" × 2'6" has been allowed at one end for access.
Such a shelter is assumed to be capable of resisting all effects from
a 112 lb. bomb bursting 12'6" away
" 224 " " " 16'6" "
" 560 " " " 25'0" "

Diag. 3.


SHELTER TYPE C
Assumed to be capable of resisting direct hits from 112 lb & 224 lb bombs
Crater
12'0"
Shelter
Assumed to be capable of resisting all effects from a 560 lb bomb bursting 12'0" away.
Total vulnerable area assumed to be 33'0" × 30'0" = 110 sq. yards
Shelter assumed to be 6'0" × 9'0" inside, capable of seating 8 persons, access is assumed to be within the vulnerable area of 33'0" × 30'0"

Diag. 4.



In Table II the same comparison of areas has been made, but since the vulnerable area surrounding each shelter is much smaller than that required for a type A shelter, the ratio of areas is much more favourable for all densities of population.

The relative efficiency of the different sizes of bombs roughly corresponds to those in Table I, the lighter bombs being more efficient per ton than the heavier.

In Table III, figures for the 112 lb. and 224 lb. bombs do not appear because the type C shelter is assumed to be capable of resisting all effects from such bombs.

The figures show that in the less densely populated areas of 0.84 persons per acre the chances of a shelter being damaged are remote: one bomb in 415 would be likely to damage a shelter.

In the higher population densities the risks are, however, still of appreciable size—890 persons involved per 100 tons of bombs plus all the material destruction might be considered a reasonable return for an attack or attacks.

There are many factors which should be taken into consideration in applying these figures even approximately to densely built-up areas where shelters may be both in and under buildings and in open spaces.

The vulnerable areas surrounding the type A shelters which are vulnerable to blast and splinters would, for instance, be affected in each individual case. They would be reduced by adjoining construction if it provided an effective barrier against blast, but they might be increased by the danger to the shelter represented by poorly constructed or very high adjoining buildings.

The figures for the more effective types of shelters B and C would be modified where some shelters were placed in or under buildings. In some cases the danger would be increased and in some it would be decreased.

The figures as a whole show that the danger of direct hits on shelters or in the vulnerable area surrounding them is extremely high for all areas of medium and dense population, and even in the less densely populated areas the risk is appreciable.

The Government Steel Shelters.

The exact performance of the Government steel shelters is not publicly known, and it is difficult, therefore, to relate them to the figures above, but it would appear that the Government shelter is not very different from the type A shelter which is intended to give protection against "blast and splinters from a 500-lb. bomb exploding 50 ft. away."

This phrase is in itself too inexact to form a definition—it may refer to the effects of a delayed-action bomb exploding deep in the adjoining ground, or it may refer to the direct blast and splinter effects from a percussion bomb.

The tests recently performed on the Government shelter before representatives of the Press showed that the shelter was not seriously affected by the explosion of a 500-lb. bomb 30 ft. away, the bomb being par-

TABLE II.

TYPE OF SHELTER. B. LIGHT SHELL, WHOLLY BELOW GROUND. See above.

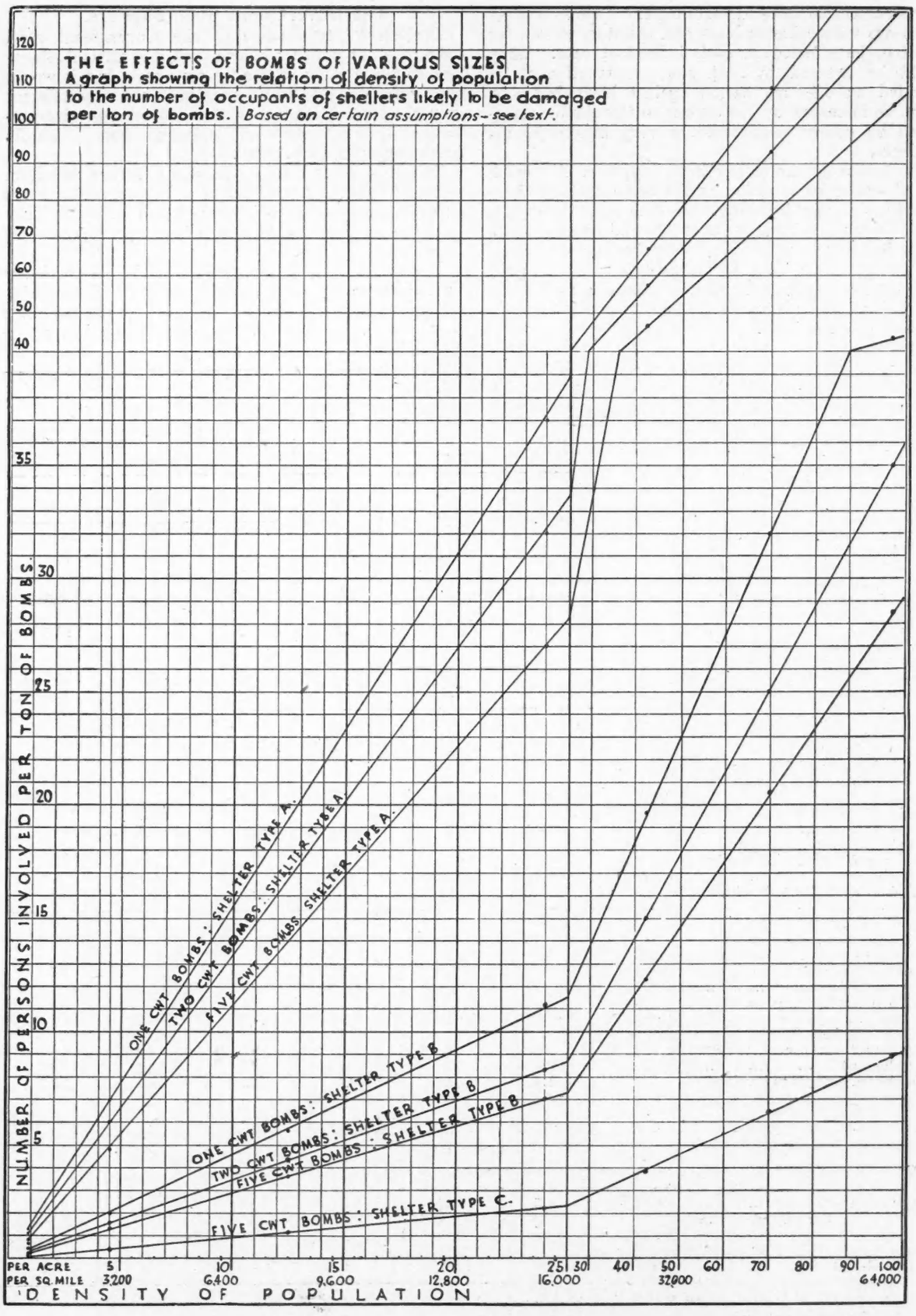
Population—Per acre	0.84	4.5	12.5	24	42.5	70	97·5
Per sq. mile ...	540	2,880	8,000	15,360	27,200	44,800	62,400
Number of shelters required (see above)	135	720	2,000	3,840	6,800	11,200	15,600
112 LB. BOMBS (1 CWT. OR 51 KILOS).							
Total plan area of shelters plus vulnerable areas (as above 110.9 sq. yds. each)	14,971	79,848	221,800	425,856	754,120	1,242,080	1,730,040
Ratio of shelter area to total area	1 : 206.8	1 : 38.7	1 : 13.9	1 : 7.2	1 : 4.1	1 : 2.4	1 : 1.7
Number of shelters likely to be damaged per ton of bombs (20 bombs)	0.1	0.5	1.4	2.8	4.9	8.0	11.1
Number of occupants involved	0.4	2.0	5.6	11.2	19.6	32	44
224 LB. BOMBS (2 CWT. OR 103 KILOS).							
Total plan area of shelters plus vulnerable areas (as above 173 sq. yds. each)	23,400	124,500	346,000	664,000	1,180,000	1,940,000	2,700,000
Ratio of shelter area to total area	1 : 133	1 : 24.9	1 : 8.9	1 : 4.7	1 : 2.6	1 : 1.6	1 : 1.15
Number of shelters likely to be damaged per ton of bombs (10 bombs)	0.075	0.4	1.1	2.1	3.8	6.2	8.7
Number of occupants involved	0.3	1.6	4.4	8.4	15	25	35
560 LB. BOMBS (5 CWT. OR 254 KILOS).							
Total plan area of shelters plus vulnerable areas (as above 354 sq. yds. each)	47,790	254,880	708,000	1,359,360	2,407,200	3,964,800	5,522,400
Ratio of shelter area to total area	1 : 64.5	1 : 12.2	1 : 4.4	1 : 2.3	1 : 1.3	1 : 0.78	1 : 0.56
Number of shelters likely to be damaged per ton of bombs (4 bombs)	0.06	0.33	0.91	1.74	3.08	5.12	7.13
Number of occupants involved	0.24	1.3	3.6	7.0	12.3	20.5	28.5

TABLE III.

TYPE OF SHELTER. C. HEAVY CONSTRUCTION, BELOW GROUND, 8 PERSONS CAPACITY. See above.

Population—Per acre	0.84	4.5	12.5	24	42.5	70	97.5
Per sq. mile ...	540	2,880	8,000	15,360	27,200	44,800	62,400
Number of shelters required (see above)	68	360	1,000	1,920	3,400	5,600	7,800
112 lb. and 224 lb. bombs : proof against a direct hit.							
560 LB. BOMBS (5 CWT. OR 254 KILOS).							
Total plan area of shelters plus vulnerable areas (as above 110 sq. yds. each)	7,490	39,600	110,000	211,400	374,000	616,000	858,000
Ratio of shelter area to total area	1 : 415	1 : 78	1 : 28.2	1 : 14.7	1 : 8.3	1 : 5	1 : 3.6
Number of shelters likely to be damaged per ton of bombs (4 bombs)	0.0096	0.05	0.14	0.27	0.48	0.8	1.11
Number of occupants involved	0.077	0.4	1.12	2.16	3.86	6.4	8.9

b


THE EFFECTS OF BOMBS OF VARIOUS SIZES
A graph showing the relation of density of population to the number of occupants of shelters likely to be damaged per ton of bombs. Based on certain assumptions – see text.
NUMBER OF PERSONS INVOLVED PER TON OF BOMBS.
120
110
100
90
80
70
60
50
40
35
30
25
20
15
10
5
ONE CWT BOMBS: SHELTER TYPE A.
TWO CWT BOMBS: SHELTER TYPE A.
FIVE CWT BOMBS: SHELTER TYPE A.
ONE CWT BOMBS: SHELTER TYPE B
TWO CWT BOMBS: SHELTER TYPE B
FIVE CWT BOMBS: SHELTER TYPE B
FIVE CWT BOMBS: SHELTER TYPE C.
PER ACRE 5 10 15 20 25 30 40 50 60 70 80 90 100
PER SQ. MILE 3200 6400 9600 12,800 16,000 32000 64,000
DENSITY OF POPULATION

The curves given in the above graph have been plotted on the basis of the foregoing investigations. The scales of the ordinates have been changed at two points in order to bring into the one graph the ratios of the persons involved to the densities of population, for thickly-populated areas, and yet at the same time to retain at the lower limit, i.e., for thinly-populated areas, clear distinctions between the efficiencies of the several types of shelters under bombardments of the same total tonnages but of bombs of different weights.

The curves enable a direct comparison of shelter efficiencies to be made and therefore form some guide to the type of shelter required for any given set of conditions.

It is not the purpose of this article to attempt to adduce the permissible total of casualties nor to decide what is the profitable return to an enemy, but if, for example, it were considered that five persons would be allowed to be involved per ton of high explosive, then the graph shows that Type A shelters are efficient to this extent only for densities up to 3 people per acre, that Type B is efficient up to densities of 11 people per acre, and that Type C is efficient up to densities of 55 people per acre.

tially buried in the ground (reports of a depth to which the nose of the bomb was buried vary from 1 ft. 6 in. to 3 ft.).

It is difficult to determine whether the effect on the shelter would be greater or less if the bomb had been buried to the depth it would be likely in practice to reach before exploding, and, of course, the test gives no guide to the effects of a fragmentation bomb exploding on impact.

Until the details of this and other tests are available to the public no exact value can be given to the protection offered by the shelter, and it would, therefore, be best to assume that its performance would approximate to that of the type A shelter referred to above. The type A shelter has, however, been assumed to give equal protection in all directions; the absence of an adequate door renders the Government shelters vulnerable to both blast and splinters from an appreciable zone.

Conclusion.

Unless bomb-"proof" construction is used throughout a particular district, there must always be a definite risk of some shelters being hit; the use of partial protection, therefore, pre-supposes that we are prepared to allow a certain proportion of casualties to occur over and above those which occur outside the shelters.

The strength and design of the shelters will directly control this proportion. In fixing a level of protection we are therefore also fixing a proportion of casualties which we are willing to allow.

It is at this point, perhaps, that the subject becomes "political," and might be left in other hands; but it surely is the duty of the technical professions so to analyse this and all the other factors relating to protection that the full facts and the relative values are clear for all to see before a decision is made by laymen.

A.R.P. Structures.

Suggestions for a Practical Effort to Provide Immediate Protection by Municipalities and Private Enterprise.

By Stanley Hamp, F.R.I.B.A.

THE problem of making provision in time of enemy air raids can be divided under two primary headings:—

(*a*) The necessary works to make existing buildings useful whilst detracting the minimum from their present usefulness.

(*b*) To erect entirely new structures as shelters which shall also be useful for purposes of commerce in peace time.

The need for the immediate provision in the shortest time makes it necessary to employ both methods.

Air raids in any future war, particularly between first-class powers, will be on an entirely different scale and more devastating than those of the 1914 war, the recent experience in Spain and the Far East. Apart from the enormous destruction of property there will be wholesale massacre of the civil population unless really adequate air raid protection is given.

It is possible that an aeroplane flying at great height and speed can drop its bombs several miles from its target and be on its way back to its base before the bomb actually bursts. Although it is extremely difficult to hit a given object, it is absolutely certain that should a raid take place over a densely populated area (such as the East End of London) the authorities must expect serious casualties running into thousands.

It has been suggested that air raid attack might take two forms, a *knock-out blow* or *attempt to wear our resistance down*. The former would be directed against London, the latter would be against other vulnerable points throughout the country, such as munitions centres, power stations, aerodromes, etc.

There is little doubt that an enemy would be prepared at great loss to themselves to lay London in ruins. There is very little question that in the event of a European war, the surprise raid, aimed at paralysing the enemy's nerve centres, would be immediate.

An enemy has at his disposal three kinds of bombs, two of which are destructive to buildings and life and the third chiefly to life: (1) High explosive; (2) incendiary bombs; (3) bombs distributing gas.

Of these three the Government appear to have directed the most attention to the third, and whilst the suffering caused by these bombs to the victims is undoubtedly intense, the numbers that may have to be dealt with might conceivably be very small as compared with the damage that may be caused by bombs having potentialities for material as well as personal damage of a more diversified type and over a much larger area.

Since practically all air attacks over this country would have a psychological rather than a military objective, it is of the first importance that science and constructive knowledge shall minimise to the utmost extent the effect of such attacks.

London as a main objective can be reached in about seven minutes from the sea and, on a cloudy day or at night with engines cut off, the machines can reach and pass on beyond London without any warning of their presence except by the amount of damage they inflict. It is therefore essential that provision be made for persons to occupy such buildings as are selected as shelters for lengthy periods and to have knowledge of how to find them in darkness and by the shortest routes.

To those who during the Great War were engaged in assessing damage by enemy aircraft and who therefore saw the effect of the various bombs, it is obvious that the provision of shelters for the population at large is not receiving sufficient attention. Neither is it yet realised that no adequate protection can be given without a very large expenditure of private or public funds.

In considering what precautions might be taken it is necessary to enumerate those methods which are under consideration, such as:—

(*a*) Evacuation, and Holiday Camps.

(*b*) Trenches in our open spaces, concrete lined and covered and Steel Shelters to the individual home.

(*c*) Shelters:—(1) Underground portions of buildings; (2) Underground Garages and multi-storeyed buildings.

(*d*) Bombproof strongholds: (1) Heavily reinforced steel and concrete structures; (2) tunnels constructed 60 feet below ground level.

Evacuation.

There is little doubt that of all the previously mentioned precautions evacuation is of the first importance. Unfortunately, with the utmost provision that can possibly be made there will still remain in our large cities a great number of men and women who will be unable to leave, particularly of the working class. It would appear, therefore, that the greatest harm would prevail in the densely populated working-class area. It is therefore urgent that A.R.P. provision should be

made in these districts. In the outlying districts of large towns and the smaller provincial towns and villages there is not the same urgent necessity.

Trenches in Open Spaces.

There is little doubt that trenches which are to be constructed in our open spaces are primarily intended as emergency shelters for those people who happen to be in the particular neighbourhood at the time. They can never become an adequate air raid shelter for long periods, but they will protect from splinters, flying stones and concussion.

Such trenches would in all probability have to be constructed in our public parks and open spaces. It would be difficult to house very large numbers and by their very nature they could not be used for continuous long periods unless they were properly drained and ventilated, and it is very doubtful whether the public would make use of them. In any case there would be large areas in the densely populated districts where they could not be constructed.

In Germany the centres of the wide roads have, in many places, been constructed as public shelter trenches at considerable depth and covered with concrete and earth.

Shelters.

It has been found in practice that people sheltering even in well-built houses, although protected from splinters, are more often than not killed by falling masonry, due to the collapse of the building caused by concussion from a high explosive bomb dropped even some distance away.

In Spain it has been found that so many people have been buried for days under debris that cellars have been forbidden as shelters.

Experience gained from aerial bombardments in both Spain and the Far East has gone far to confirm that reinforced concrete buildings, due to their homogeneous construction, resilience and great inherent strength, are perhaps the most suitable form of construction. Being monolithic structures, they are capable of resisting the blast pressure from explosion.

Experience in Madrid has shown that the shock from a medium bomb will burst a street main, so that it is important to remember that any form of underground shelter must be protected against flooding from such a cause.

It is also essential to remember that wherever air raid shelters are provided, unless a reasonably high proportion of the people can get into these shelters before the bombardment begins, a frightened population may crowd the streets and cause panic when masses of shrapnel and pieces of anti-aircraft shells begin to fall, seriously hindering fire engines and ambulances from fulfilling their necessary duties.

The authorities will have to face a double task of looking after the bodies and the minds of the survivors as well as salvaging the devastated areas.

It has been said that a squadron of 270 aeroplanes could drop 400 tons of bombs in half a minute and probably kill 8,000 people and injure some 15,000 people, and this could be repeated several times a day.

Underground Shelters.

There is a proposal to construct public garages under our public squares to be used as shelters for housing large numbers in war time. Unless such provision is constructed to be proof against the high explosive bomb and unless proper facilities for draining, ventilation, sanitary conveniences and electric light are provided, these would be most undesirable. To make these provisions would be a very costly matter. One result must not be lost sight of. If such excavations are not some distance below the ground surface they will probably cause the destruction of all the large trees which now exist; which would mean the destruction of a very valuable natural beauty of which London in particular is rightly proud.

In Barcelona tunnels have been arranged 45 feet under the buildings, forming long galleries approached from the pavements, so arranged that they give access one to the other, in case of accidents.

Multi-Storey Shelters.

This is the form which, like the previous suggestion, would have a use in peace time. It is thought that it would be more worth while to embark upon a larger capital outlay if by so doing the structure could serve some useful purpose when not required for its war-time use.

Although it is recognised that the erection of such a structure would of necessity mean the placing of a larger number of persons on a smaller superficial area, against this objection it is contended that such buildings could be erected where they were most serviceable and therefore provide a substantial contribution, and if spaced widely apart the chances of a direct hit from a high explosive bomb would be somewhat remote.

Bombproof Strongholds.

The proposal to construct heavily reinforced steel and concrete shelters is very limited in its usefulness as far as the mass of people is concerned. The cost would be prohibitive except in key positions where important officials must maintain their duties in very vulnerable places.

The suggestion of providing bombproof tunnels under our cities, if adopted, would provide probably the most certain protection one could desire. As they would have to be placed 50 ft. in the ground, all the necessary amenities for a large population they should be made to house would mean not only a very vast expenditure of money but too long a period necessary in their construction.

From the foregoing it will become apparent that A.R.P. is an immediate necessity and can be tabulated in order of probable execution as follows :—

(1) The strengthening of all existing buildings suitable.
(2) The provision of trenches in our open spaces for emergency shelters and Steel Shelters to the Individual home.
(3) Structures to house large numbers above ground or under ground (to be proof against small bombs, incendiary bombs, splinters and concussion, but not proof against a direct hit from a high explosive bomb).
(4) Deep tunnels under our towns capable of withstanding the high explosive bomb.

It has been found that the safest place in a building is on the first floor against internal walls, where there are concrete floors, or on the concrete staircases; and the provision of shelters within these buildings is a matter that should receive attention. It is understood that there is no poison gas yet devised which is heavier than air, so that persons situated at a reasonable level above ground would be free from the effects of gas. With regard to splinters, it was found that whilst splinters scattered on the impact of the bomb, considerable damage and piercing was caused to the walls of the ground floors but the upper floors, apart from windows, usually remained unscathed.

With regard to flat roofs of schools and warehouses, a layer of sand placed on the existing roof with 4 in. or 5 in. of reinforced detonating concrete slab above the sand covered with waterproofing material, with the rainwater pipes, etc., extended to the new level, would render most flat-roofed buildings immune from serious damage. The extra weight of the roof would require additional support in the shape of pillars and beams and might quite easily be added to existing buildings.

Work to Existing Buildings.

As to the conversion of existing buildings to public air raid shelters, only those of steel frame or reinforced concrete should be considered, as they are the only type of buildings found by experience to withstand the effect, to any reasonable extent, of the blast from bombs; and it is suggested that an immediate survey be made of such buildings by experts and that such work as would take, say, more than three days, should be at once carried out and that for the remainder the necessary partitions and such like should be made, fitted, numbered and stored not more than half a mile distant in some convenient spot; and that the plans resulting from such surveys and the other particulars should be contained in a glass-fronted box in some reasonably conspicuous part of the building, the glass being clearly labelled as to what is contained in the box. All buildings scheduled as air raid shelters should at once have an electrically-illuminated blue cross sign outside so that the public may become in time of peace familiar with the location of such buildings. The cost of such constructive work and compensation for any loss of efficiency of buildings so altered should be borne by the public exchequer unless the owners are sufficiently patriotic to carry out the work at their own expense.

In areas where there are a large number of two-storeyed or other dwellings and no buildings suitable for conversion, air raid shelters should at once be constructed either above or under ground. Such buildings should be gas- and bomb-proof and properly equipped, and their position and the interior of the shelters themselves made familiar to the inhabitants.

Structures to House Large Numbers.

The alternative of providing for the greater concentration that will become essential must be considered on its merits in the particular area to be served. The underground structures have some advantage over the multi-storey building. They also possess disadvantages which the latter does not possess; however, it will be found that the open spaces available for such a purpose will not always be obtainable where the working classes are so densely housed. It is therefore suggested that if this demand is to be quickly dealt with the ferro-concrete building above ground will prove of most use.

Of the type of buildings which might be considered the most useful to be built or converted into air raid shelters, multi-storeyed garages appear to offer the best solution in the centres of towns or cities as they would be revenue-producing during peace time, when their positions would be familiar to the public at large, and would provide large open spaces for shelter and medical treatment during war time. During peace time, however, they might not provide sufficient revenue to cover the cost of ground rents or provide interest on the extra capital expenditure involved in erecting such buildings in a manner suitable for use during war time. A self-supporting garage with a reasonable prospect of day and evening trade would require—if to be erected on a site in London—a site costing not more than 2s. 6d. per foot for ground rent and to be erected in reinforced concrete at a cost not exceeding 1s. per foot cube. In provincial towns of the largest size such as Manchester, Liverpool, etc., the cost of the site should not exceed 1s. per foot super as the demands on the garaging space in the evenings would be much less and the patrons of the garage would not pay for garaging at any time on the same scale as do those visiting London.

It is probable that the extra cost involved in erecting such a building to serve the dual purpose suggested would be about 8d. per foot cube—expended in providing stouter columns and beams, thicker floors and double-thickness roofs packed with sand, also steel shutters to windows and doors, air locks to entrances, stored lockers and partitions, medical supplies and all the other accessories to be held in readiness within the building for almost immediate use. This difference in cost both as to site and specialised building should be met out of the public purse without, however, any control of the person running the garage except in time of war when the building would be taken over by authority and the owner paid an agreed rent to cover the interest of the money invested, the ground rent and other overhead charges. It should be noted that such a building would require to be independent during war as to electric supply for its various activities.

Plans for a typical garage on an island site are illustrated. The extra cost of erecting other types of buildings adaptable as air raid shelters would be very similar but would vary downwards as the cubical content increases.

It is suggested that all local authorities should be asked to supply sites for such buildings as necessary and suitable for their own demands and that the Government or private enterprise should take over the erection of the buildings.

These buildings might be so constructed to have a use during peace time but capable of being fitted out immediately for use during war time.

The types of building that it is contended would be possible are the following: (1) Public garage; (2) community centre; (3) health centre and clinic; (4) public wash-house.

All such buildings could be designed to fulfil all the requirements of a building to be proof against all war risks except the high explosive bomb and could be so planned that the conversion could be easily and readily carried out.

These buildings should be large enough not only to form shelter to the thousands who would require protection, but they should each contain provision for a decontamination unit and first-aid unit and clearing station. Such provision will be of vital importance after every raid. If some such buildings were provided a great step would have been taken towards solving this very difficult problem.

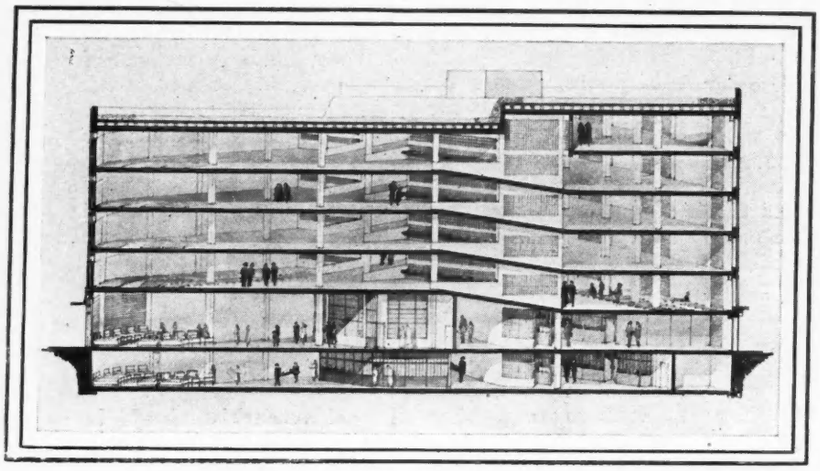
The Italian Government have recently tabled a Bill that provides that public land may be let to private companies or individuals for a period not exceeding 60 years and at a nominal rent, in each case, of 100 lire (about £1) a year. The concessionaires, as a compensation for the expense incurred in building suitable shelters underground, will be allowed to use the surface area for commercial purposes, including cinemas and theatres, and are also to be exempted from various taxes.

For this reason the plan prepared shows what would be possible on a particular site where a public garage might be erected by private enterprise assisted by Government loan, and it is contended that the idea underlying the suggestion might be extended in many directions with similar results.

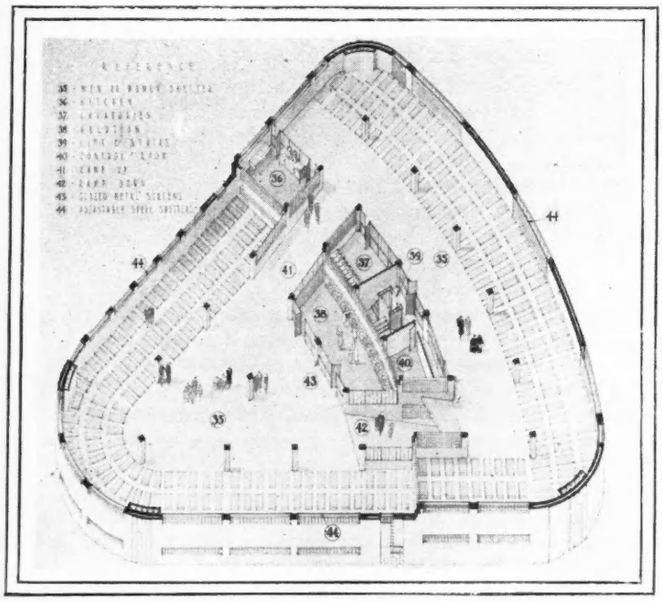
This plan is for an actual garage and is to be erected in an important provincial town, and hence the reason why this particular shape of plan is shown.

The result might be that instead of spending huge sums of money for accommodating in time of war those people who must be so protected without any return whatever on such expenditure, the accommodation could be partly provided by private enterprise. Furthermore, the type of buildings suggested would not ruin our parks and squares; instead of building structures that would of necessity remain useless unless war came, and further, instead of having buildings that would be deteriorating year by year, the country would possess a group of useful buildings that might go a long way to solve the present parking problem and also provide a very useful contribution to the Health and Social Service of the community.

The procedure would be that immediately war was probable the local body would take over the whole building and convert it to its new purpose. In the case



CROSS SECTION.



UPPER-FLOOR PLAN.

of a garage building the cars would be taken over and provide at once the means of transport for the people who were to be housed within the unit. The A.R.P. Wardens would take over the portion prepared for decontamination. The nearest hospital would take over and staff the First Aid Unit as a Clearing Station with doctors, nurses and hospital equipment.

The working classes for whom these shelters would be primarily intended would recognise that the Government had made a serious effort on their behalf which would go a very long way in preventing a feeling of resentment at a time when the support of a working-class population is vitally important.

A Convertible Garage.

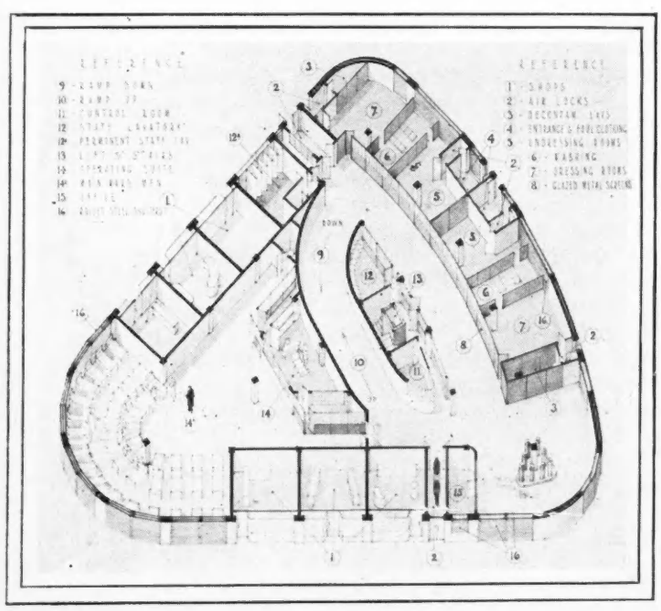
The plan shown is the joint effort of well-known experts in their particular subject, and has been prepared to show in practical form what might be possible. It is not, however, intended in any sense to be a final plan.

It is impossible to describe it in full detail, but the following description will give a general idea of the proposal.

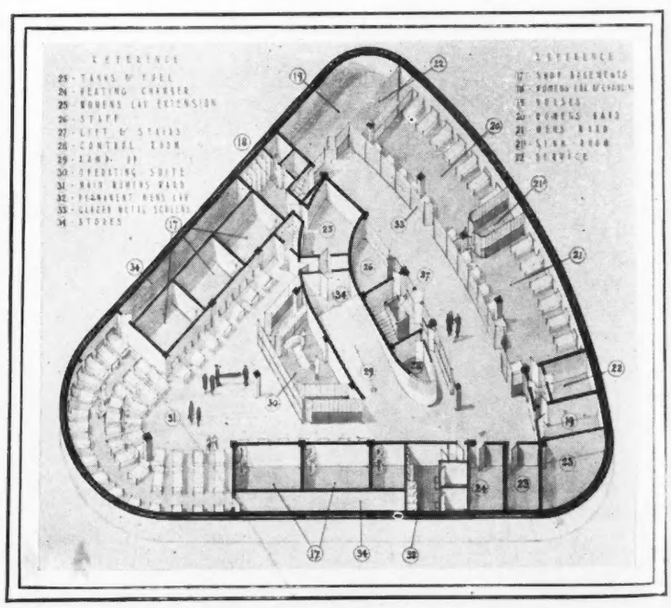
The building has been designed to serve as a modern up-to-date garage in peace time, which is to be converted on the possibility of war into an Air Raid Shelter, Decontamination Unit and First Aid Clearing Station. It is to be erected on a site chosen as a detached building and if possible of a shape to avoid right-angles.

It is to be a ferro-concrete structure throughout, including the external walls, the external walls themselves also to be faced with 4 in. stone supported by the concrete construction, with 2 in. hollow space forming an air cushion behind the stone as provision against blast.

The floors are arranged to make it possible for ramps to be used as a means of access from floor to floor. In addition, there is a central staircase and a lift. The whole of the inside of the building is left with bare concrete to be distempered and the structure throughout will be of the most economical kind except that special provision is made by means of properly con-



GROUND-FLOOR PLAN.



FIRST-FLOOR PLAN.

A GARAGE BUILDING PREPARED FOR AN AIR-RAID SHELTER, DECONTAMINATING UNIT AND FIRST-AID UNIT

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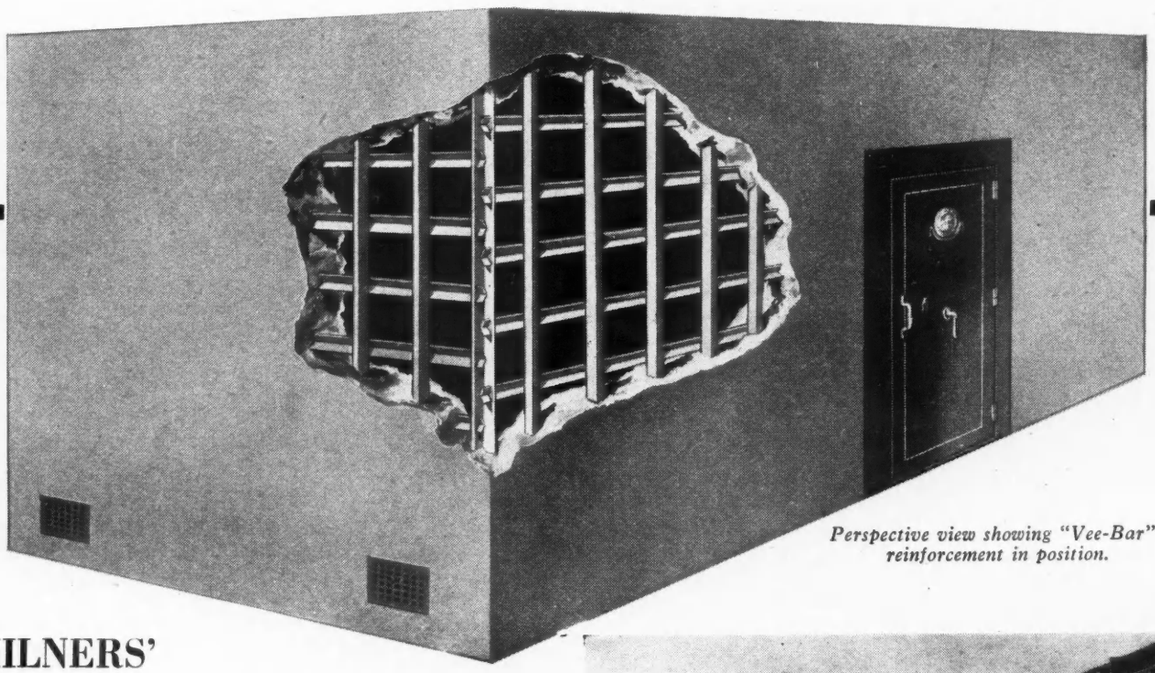

Perspective view showing "Vee-Bar" reinforcement in position.

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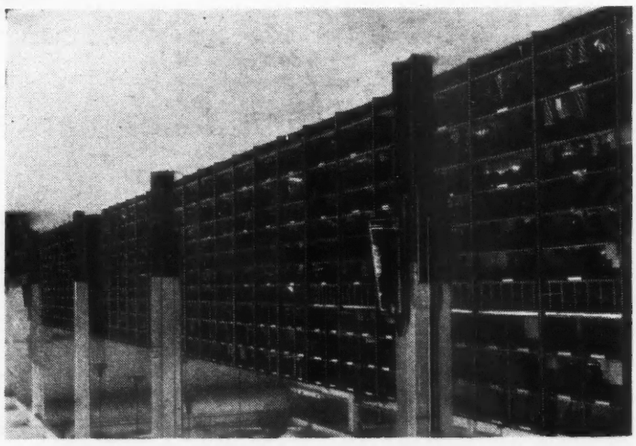

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structed steel shutters, so that all windows and openings can immediately be sealed against attack.

Of necessity provision must be made for additional electric services, heating and plumbing services which would be essential for war conditions.

To provide quickly for the building to be divided into several units in war tine, special metal divisions and shutters are provided and housed in the basement until required.

In case of any breakdown in the electric services a stand-by electrical installation is provided.

Lock-up shops could be provided where there would be a demand.

The roof is specially designed to resist the small bomb and incendiary bomb.

The upper floors, in case of a raid, are to be used as the air-raid shelter, and provision is made for sanitary services, also kitchens.

The ground floor and the basement floor will be used for the Decontamination Unit and the First Aid Unit. The Decontamination Unit is complete in itself with separate access to First Aid Unit and the shelter above.

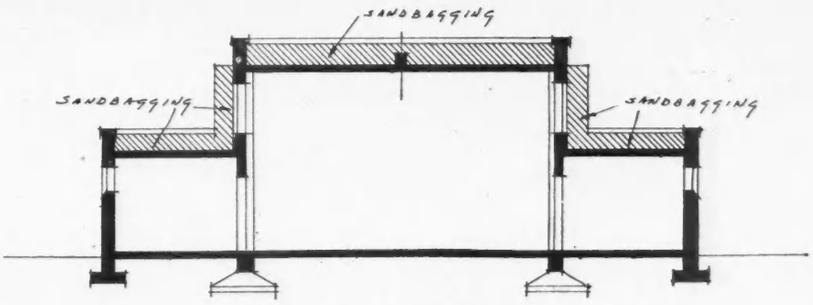
Apart from the Decontamination Unit there is a separate entrance on the ground floor for those going to the shelters on the upper floors, and a separate entrance on the other side of the building for the cases arriving for the First Aid Unit. In this unit the male cases are dealt with on the ground floor and female cases in the basement. In the basement, in addition, two 20-bed wards are provided, one for male and one for female, with services and nurses' quarters. Both in the male and female First Aid Section is provided a small operation unit with anæsthetic room, theatre, and sterilising room. The whole building will be air-conditioned by means of plant placed on the roof, adequately protected.

It is undoubtedly the case that the public at large have at the present time a very confused idea about A.R.P. and, further, appear to be under the impression that the Government have equally confused notions. A.R.P. being a matter of military defence should surely be directed by the War Office, whose knowledge of concrete defences should at least be equal to that of the Home Office. Since all the population in time of war would, owing to air raids, be technically in the firing-line, they should be minutely instructed in groups in time of peace as to what is required of them in time of war and, as far as practicable, rehearse in time of peace so that confused and tragic delays do not occur. These instructions should be given by capable military R.E. officers to the various local territorial units who, in turn, should instruct the public—wearing military dress at the time.

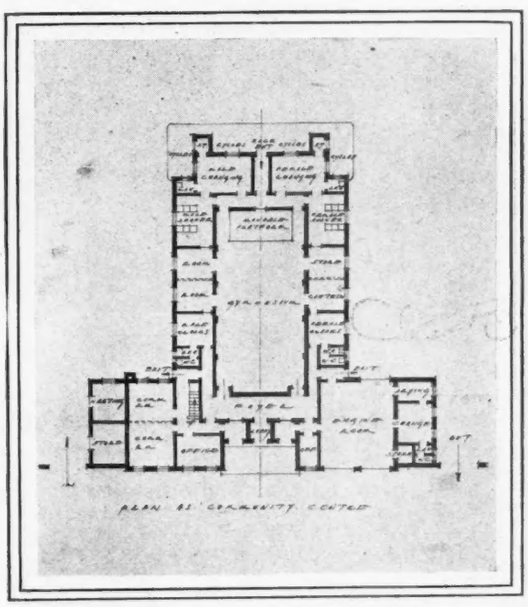
A First and Useful Step now being taken by a Rural District Council.

A Community Centre designed by Mr. J. F. Watkins for the Amersham Rural District Council and which they are about to erect at selected points throughout the area under their administration, is illustrated.

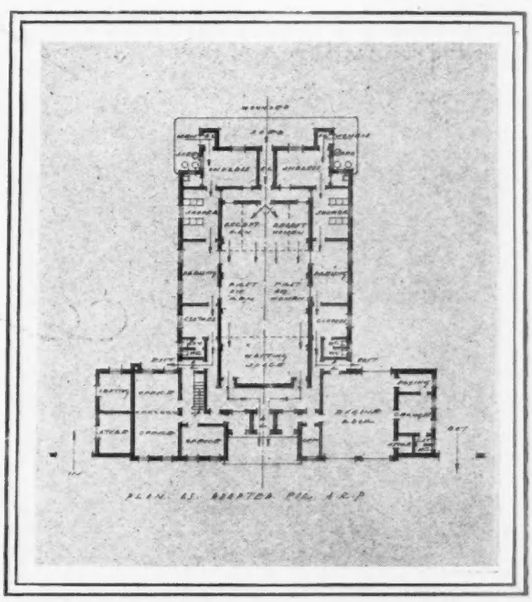
The primary purpose of the building is to be a centre for social activities in the district, arranged on the lines suggested by the National Council of Social Service and the National Fitness Council. Accommodation is provided suitable for use by the various bodies engaged in social work, musical and operatic societies and local gymnastic and physical training clubs. In addition, it is proposed to provide accommodation for the local voluntary fire brigade and also committee rooms which are available for use by the Rural District Council and other local bodies for various purposes. It was also felt that



CROSS SECTION THROUGH COMMUNITY CENTRE.



A PROPOSED COMMUNITY CENTRE.



[COMMUNITY CENTRE AS ADAPTED FOR A.R.P.

the organisation to be built up for A.R.P. purposes could usefully be housed in the same building, and therefore the layout of the scheme should be such that in times of crisis the accommodation could be converted for use as an A.R.P. centre and first aid post, without involving any structural alterations. The advantages of centralising the offices for A.R.P. administration with the decontamination and first aid facilities, also fire-fighting services, are obvious, and do not call for explanation. These facilities would also be available in normal times for the purpose of A.R.P. instruction. It will be seen by comparison of the alternative plans illustrated how very easily this can be arranged, the only further work necessary being the erection of temporary screens in the gymnasium to form the first aid rooms.

The structure will consist of ferro-concrete frame and roofs faced with brick. The roofs are flat, with parapets on all sides to facilitate protection by sandbags when the necessity arises.

It is felt to be important for the public to realise that in a building of this nature provision is being made to meet all the probable requirements of A.R.P. work, and that they should accustom themselves to the idea that in times of crisis this is the building to which they should apply for advice, instruction and possibly treatment.

The psychological effect of this permanent provision of such facilities should be very valuable and in the interest of the public as a whole. It is estimated that the cost of the building will not exceed £10,000.

Summary.

1. Prepare and plan for a definite number of people for evacuation and Holiday Camps.

2. Form and instruct groups of volunteers for special duty in each area and rehearse under capable instructors under the control of R.E. officers to the various local territorial units, wearing military dress at the time.

3. Construct trenches as emergency shelters in all open spaces suitable and steel shelters to the individual home.

4. Make survey of all existing buildings capable of being easily converted for shelter purposes and proceed where possible with the necessary work at once.

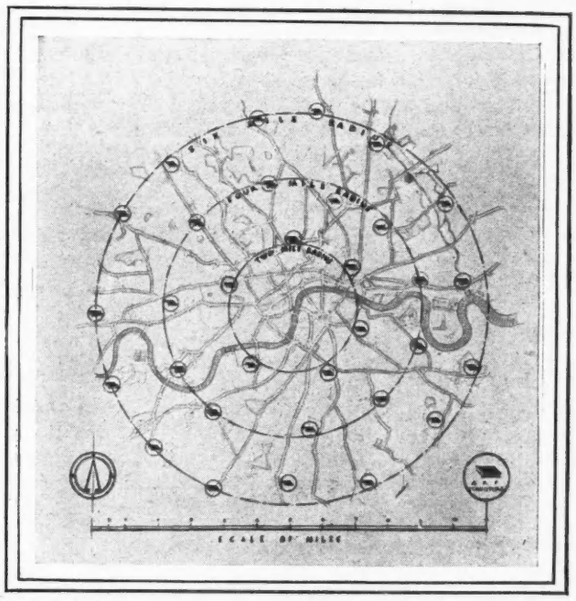
5. Erect at once in most suitable positions new buildings for shelters with decontamination units and first aid units, such sites to be provided by the municipal bodies and with a contribution from Government funds for cost of erection. (Plan accompanying illustrates how and where these might be arranged within the London area.)

6. Tunnels 50 feet underground below streets and buildings as now carried out in Barcelona.

7. Public garages under parks and open spaces constructed low enough and sufficiently protected against high explosive bombs.

The plan of London illustrated shows a possible position for the erection of shelters and first aid units to be so designed that they can have a peace-time use.

If they are constructed in steel frame or ferro-concrete and if sound organisation is applied in their construction, it is estimated that within six months a large number of such buildings could be completed. Each local authority could, if desired, erect such buildings, and probably with the assistance of Government funds and private enterprise.



SITE PLAN OF LONDON, SHOWING SUGGESTED POSITIONS FOR SHELTER BUILDINGS.

It is suggested that authorities should consult with local members of the architectural profession who could give necessary advice in selection of site and construction of buildings.

The foregoing has been written to place on record a possible plan to meet the occasion. It has been felt that unless and until some definite plan is so prepared, that everyone can grasp the full intention of what is the immediate need, nothing will materialise in time for a possible early outbreak of war. To be in time is the essential factor if we are to succeed.

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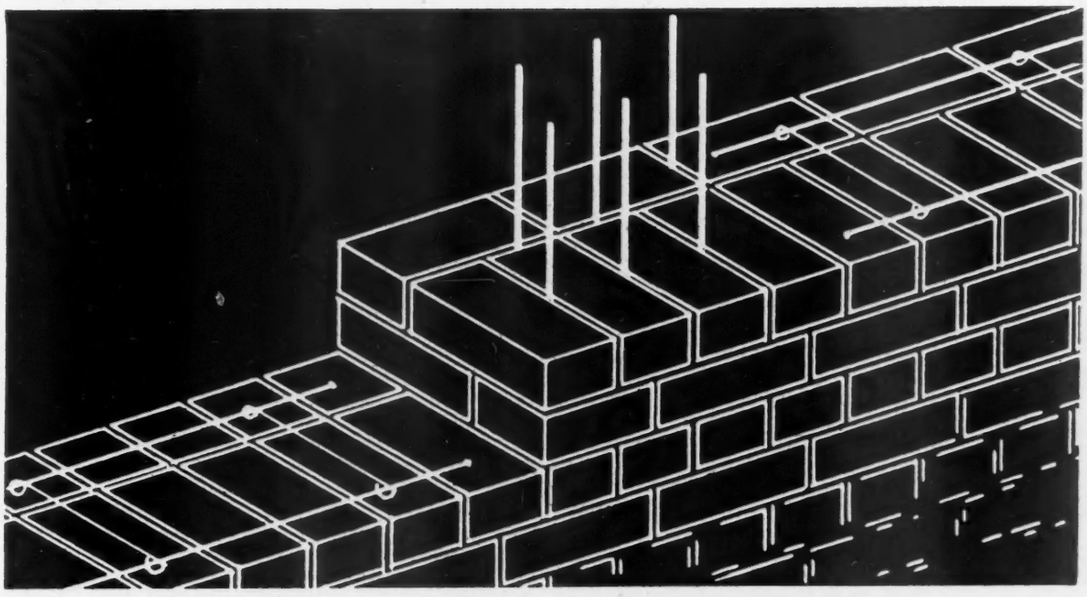

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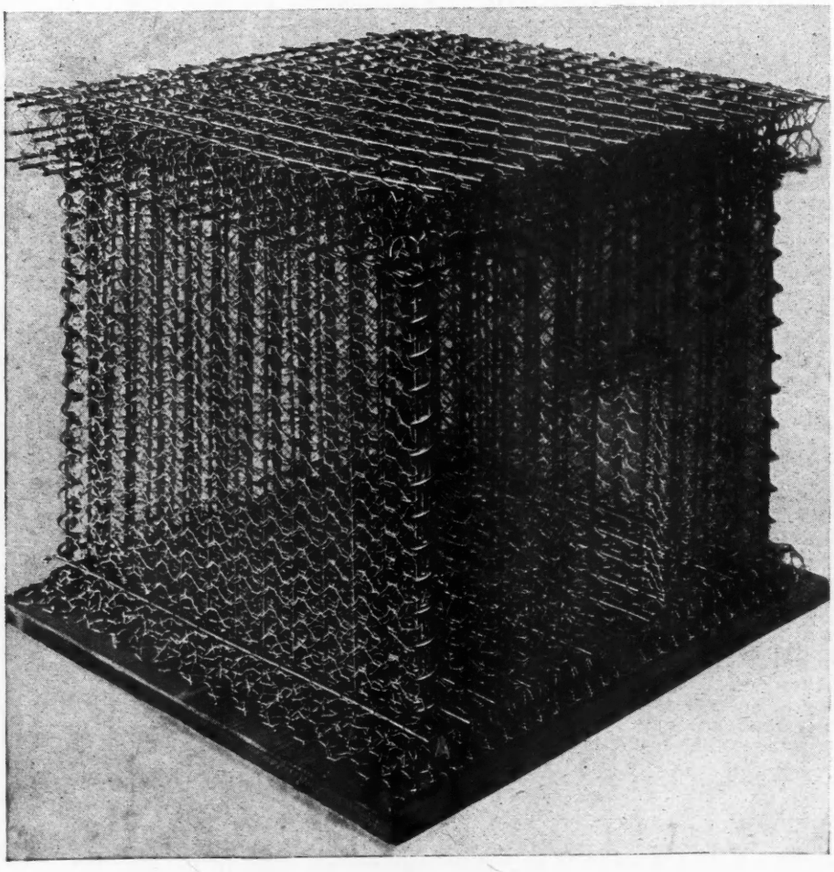

Model showing reinforcement for small type Bombproof Shelter.

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Home Office Air Raid Shelter Policy.

Engineers' Report.

A REPORT by Mr. David Anderson, LL.D., B.Sc., M.Inst.C.E., Mr. B. L. Hurst, M.Inst.C.E., and Sir Henry Japp, K.B.E., M.Inst.C.E., who were appointed by the Lord Privy Seal to consider certain aspects of the problem of air raid shelters —has now been issued as a White Paper (Cmd. 5932, H.M. Stationery Office, price 2d.). Following is the full text of the White Paper [The cross-heads are ours. —ED.] :—

We have had the opportunity of discussing with the Lord Privy Seal some of the problems of the shelter policy, and in particular the proposal to provide sectional shelters for the population of vulnerable areas in their own homes.

In the first place we would record our wholehearted agreement with the Lord Privy Seal that the provision of a shelter in or in close proximity to the home of every citizen in vulnerable areas is a sound policy, and that such shelter should provide reasonable protection against blast and splinters from the near-by explosion of a medium-sized H.E. bomb and against the collapse of the superstructure, and we have now to record our opinion as to how far a sectional steel shelter can fulfil the requirements of this policy.

The Sectional Steel Shelter.

I.—(*a*) A sectional steel device is one method of providing such shelter. There are a number of such devices on the market and we consider that two or three standard types could be adopted which would satisfy the requirements and which would enable a large number of firms to adapt their plan to the production of one or other of the types with the least possible delay.

(*b*) Such a shelter should measure not less than 6 ft. by 4 ft. 6 in. in plan and should not be less than 6 ft. high from the crown of the arch to the floor. This shelter would hold four persons for a short period and might even in an emergency hold six persons. It would, therefore, form the minimum shelter for the two-storeyed terraced house or cottage type of modern house, which on the average accommodates rather under four persons. The dimensions given are, in our opinion, the absolute minimum for three reasons :—

(i) Anything smaller would have no market value above its value as scrap, whereas a structure of the minimum size which we recommend would have a definite value for other useful purposes.

(ii) That there would be serious risk of very rapid suffocation in any smaller shelter in the event of the exits being blocked and

(iii) Anything smaller would be unacceptable to the people and we would particularly emphasise the danger of issuing a type of shelter which could only be entered by crawling and in which only a crouching or recumbent attitude is possible.

(*c*) The weight of such a shelter would be from 5 cwt. to 7 cwt., and the maximum weight of any one member would vary from 60 lb. to 100 lb.

In our judgment these shelters could not be distributed quickly and easily. For every million persons provided for the weight of metal to be handled would be from 60,000 to 80,000 tons or on the average 25,000 lorry loads. The shelters must be distributed by lorries and must, therefore, be distributed in advance of an emergency owing to the claims upon transport at such a period.

(*d*) These shelters could be mass-produced and be capable of erection by two men of average strength and no special skill. The design should be confined to two or three types at the most.

Position Occupied by Shelters.

II.—With regard to the position to be occupied by these shelters we are definitely opposed to the placing of them within houses for the following reasons :—

(*a*) The ordinary ground-floor room of the small house only measures about 10 ft. by 12 ft. and therefore such a room would be to all intents and purposes out of action whilst the shelter was in it. Every air raid will reduce the available accommodation and increase the pressure on undamaged houses in already overcrowded areas, and it is therefore an error to render any accommodation useless for normal purposes.

(*b*) The shelter would provide no additional protection against splinters beyond that which the walls of the room provide, and would have no resistance to splinters entering through the doors or windows.

(*c*) Unless the floor of the room were removed and the shelter placed on the ground below (generally about 15 in. below the floor) there is danger of the shelter being driven through the floor by the collapse of the house, to the added danger of the occupants.

(*d*) Unless the shelter were strongly anchored to the floor, the collapse of one side of the house would incur the risk of its displacement and distortion.

(*e*) There is a very serious risk of debris from the fall of the house forming a solid wedge of masonry at the ends of the shelter making the rescue of the occupants very difficult. For the same reason there is a risk of the occupants being suffocated from lack of air and by the dust from the debris. The higher the house the greater will be this risk.

(*f*) Assuming, as seems most likely, that an attack with H.E. bombs will be accompanied by the use of incendiary bombs, the risk that the shelter will become an oven for the trapped occupants is a very real one and one which we consider would render the acceptance by the people of the device for use inside a house more than doubtful.

(*g*) There is a risk that the entrapped occupants may be killed by the escape of gas from the domestic supply (the gas-mask is not proof against this form of gas).

A shelter device of this kind, to be provided in large numbers, must, in our judgment, satisfy public opinion. Undoubtedly most people would prefer to stay in their houses to take shelter, and though at first sight the device might seem to render this possible, the plain truth is that if they do so, within the protection of such a shelter, their chances of rescue are greatly diminished and the prospect of a lingering death increased if the house collapses. Ease of exit is the most fundamental requirement of a proper shelter and ease of exit from a sectional shelter within a small collapsed house is almost a contradiction in terms.

There is, however, in our judgment, a very definite place in the shelter policy for a steel shelter device of this kind for small houses. During the recent crisis the Home Office recommendation that the householder should dig a trench in his back-yard or garden was severely criticised on the grounds that many could not afford the cost of the materials necessary to revet the trench, and there was a demand for the free issue of material for the purpose.

The sectional device is an answer to this criticism. Placed in the garden or yard and covered with earth or sandbags it provides as good a shelter as a covered trench. It should be sunk at least partially in the ground as this not only provides increased lateral protection but also provides the earth necessary to cover the shelter. Thus protected it can be placed close to the house without serious risk from the collapse of the building.

The Applications of Shelters.

III.—The extent to which the sectional shelter may be regarded as a solution to the problem, and the numbers which would be required if it is adopted, are difficult for us to assess, as we have not the figures at our disposal to show in detail how the population of vulnerable areas is housed. We would recommend that the following principles should be adopted in assessing the extent of its application.

(*a*) The device is suitable for the cottage type of houses on the modern building estate where there is ample garden space. Owing to the flimsy nature of these buildings it is not easy to strengthen them at reasonable cost in order to provide adequate shelter within the house without considerable disturbance in peace time.

(*b*) It is suitable for the two-storeyed terraced type of house, many of which are old and unsound, provided that there is sufficient room in gardens or back-yards to erect the shelter. From the few inquiries we have been able to make it appears that in the majority of cases in London such back-yards exist. The problem of two-storeyed terraced houses without yards must, however, not be overlooked and some other solution must be sought for these.

(*c*) It does not provide the best solution for the basement house, for which we make other recommendations.

(*d*) It is no answer to the problem of providing shelters for the occupants of tenement flats where hundreds of people are housed in blocks of buildings in which the provision of family shelters is impossible and the provision of communal shelters will be necessary.

Safety Value of Shelters.

IV.—We consider that the sectional shelter which will be erected in time of emergency has a definite place in the immediate short-term policy, and will provide a reasonable amount of safety though it is less efficient than a permanent structure of brick and/or concrete, of the pill-box type, which would, in addition, have a definite peace-time use as a coal-shed, bicycle and perambulator store or garden shed, but which would be more expensive. These would be built in groups at the intersection of fences to accommodate two or four households of four people each.

Use of Basements as Shelters.

V.—(*a*) The provision of shelter in the basement house can best be provided, in our judgment, by propping the basement ceilings and providing adequate alternative exits. It must be remembered that in this type of house there is generally a family on every floor, and in many areas a family in the basement as well, or from 12 to 16 persons in every house. The basement rooms will have to be prepared in peace time to receive the props and some work may be necessary to make the provision of emergency exits possible. This will necessarily involve temporary inconvenience to the basement dwellers, but when the work has been done the basements will be no less habitable than they are at present. The props can be stored and erected by unskilled labour at the time of emergency, but when erected the basements will definitely have to be regarded as refuges for all the inhabitants of the house and the tenants must be evicted.

(*b*) As regards existing tenement flats, the problem is a very complex one and will have to be investigated in greater detail, but the provision of communal shelters might take several forms such as :—

(i) The evacuation of some or all of the ground-floor flats (or the basement if such exists) and the strengthening and adaptation in peace time of the portions evacuated. Their use as flats will cease, but uses can be found for them as play-rooms, bicycle and pram stores, etc.

(ii) The construction of permanent covered trenches in communication with the main buildings.

(iii) The construction of subsidiary buildings with definite protective value which would also have peace-time uses as children's playgrounds in bad weather, bicycle and pram stores, washing rooms, etc.

Future Legislation.

VI.—Legislation with regard to future residential buildings.—We appreciate the argument that the constant presence of an air raid shelter such as a trench in the garden which has no peace-time purpose may have a possible adverse psychological effect on the minds of children, but so long as air attack remains a definite threat we consider that the absence of a sense of protection will have an increasingly adverse psychological effect on the adult population.

The solution, in our judgment, must be along the lines of providing in every home an air raid shelter which will provide reasonable protection against blast splinters and the collapse of a super-structure, and which will have a peace-time use and to which the children will be accustomed as part of their daily life and which will therefore not have any sinister connection in their minds, and the entering of which would, in war time, be no novelty.

To meet this objective we should like to place on record our very strong view that immediate legislation should be undertaken with a view to ensuring that no residential building of whatever size or class should be erected in future without the inclusion therein of an air raid shelter, of sufficient size to accommodate all the inhabitants of the house in reasonable safety. To delay such legislation is only to add to the difficulty in war time of providing refuge accommodation.

Huge programmes of rehousing are being undertaken in our densely populated areas, which must all be considered vulnerable and, in the course of time, the areas of bad housing will all be rebuilt and to fail to take cognisance of the air raid menace in new construction is, in our view, short-sighted if not worse.

These rebuilding schemes are for the lower-paid class of workers, but we consider that the provision of air raid shelters in better-class residential buildings is equally important.

In time of war essential workers who have been forcibly evicted by the destruction of their homes through fire or by high-explosive bombs will of necessity be billeted, like soldiers in a war zone, in the most suitable and safest buildings available in the vicinity of their work. These may, and most probably will be, in the houses of the more well-to-do residents, many of whom will have been voluntarily evacuated, and for this reason we consider that the provision of an air raid shelter in or on every residential property should be compulsory.

Shelters for Wayfarers.

VII.—When the problem of providing shelter in the home is solved there still remains the problem of shelter for persons caught in the street and for the worker passing between his home and the scene of his labour. As we have already said, we share with the Lord Privy Seal his doubts with regard to trenches as a solution of this problem, although they must of necessity form a feature of the immediate policy. Trenches, however, cannot be dug in many localities where shelter is most needed, and we would urge most strongly that the policy of providing public shelters in suitable basements adequately strengthened and provided with alternative exits, which was part of the Government policy before the crisis, should now be zealously pursued. We understand that the duty of making a survey of such shelters and arranging for same was laid upon the local authorities, but we consider that if the work is to be done promptly it will be necessary to organise a comprehensive scheme in which the professional bodies of the country will be enlisted to work in conjunction with the local authorities and with the organisations of the public works contractors and the steel industry. This work is one of enormous magnitude owing to the wide distribution of the work and the amount of detail involved.

Need for Official Lead.

VIII.—There are three points on which, in our judgment, a very clear pronouncement to the public is essential :—

(*a*) If the goodwill of the public in this problem of providing shelters is to be enlisted there should be a very clear understanding that there will be no penalisation in regard to increased taxation and rating on account of the provision of air raid shelter accommodation. In his speech in the House the Chancellor of the Exchequer, on May 28, stated that there would be no such penalisation. We feel, however, that there is still no clear understanding in the minds of the public on this subject.

(*b*) With regard to the provision of basement shelters in large shop and office buildings and in the larger private premises, the committee consider that building owners would be encouraged to provide permanently strengthened basements if it were common knowledge that the L.C.C. and other local authorities were willing to relax their by-laws for steel and other materials added to the basement ceilings of existing structures solely for the purpose of rendering them safe to withstand collapse of the building above, and the committee recommend that this should be arranged for. Two such matters which might be instanced are :—

(i) That concrete " fire cover " encasement of constructional steelwork added solely for the above purpose might be waived.

(ii) That stresses not exceeding 10 per cent. above normal stresses might be authorised in the previously existing structural steelwork of such buildings, provided that such stress excess were solely due to the addition of the dead weight of added protective structure.

(*c*) As regards " pill-box " or other external shelter accommodations the committee submit that the following arrangements should be made in order to encourage private building owners to construct them at their own cost, viz. :—

(i) That concrete " fire cover " encasement of constructional steelwork should be dispensed with.

(ii) That typical designs and estimates of cost should be prepared by the Government and issued to building owners.

The committee suggests that the relaxations of Building Regulations recommended above should form the subject of new by-laws, as otherwise every case would have to be dealt with by special application and grant of a waiver, which would not only cause much unnecessary work and delay, but would tend to discourage building owners from embarking on schemes.

Conclusions.

IX.—In conclusion, we would respectfully state our firm conviction that the magnitude and urgency of this problem are so great that the utmost possible use should be made of the resources of every trade that can be employed on the work in the construction of all the forms of shelter accommodation dealt with hereinbefore to the utmost extent and at the utmost possible speed, viz. :—

(*a*) Pressed and rolled sectional shelters.

(*b*) Propped basements.

(*c*) " Pill-boxes."

(*d*) Permanently strengthened lower floors of blocks of flats and tenements.

(*e*) Permanently strengthened basements of shops, offices, and large houses.

(*f*) Communal shelters and trenches.

Only by these means can we conceive that the necessary accommodation will be made available within a reasonable period of time.

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workers were within the scope of the free distribution, and other individuals who were mainly dependent on earnings exceeding £250 might come within its scope if they had more than two children of school age.

A.R.P. IN PARLIAMENT

DEEP BOMBPROOF A.R.P. SHELTERS.

ALL sorts of suggestions for protection against bombs, including the erection of concrete pill-boxes in the suburbs, were made during a debate in the House of Lords on Thursday, last week.

In reply, LORD BIRKENHEAD explained that the Government contemplated several methods by which protection could be provided according to the type of building and its surroundings :—

(1) In houses with basements the strengthening of basements by steel sheets and steel supports.

(2) In flats or tenements by structural supports arranged so as to provide a shelter large enough to accommodate persons living in the block.

(3) In houses without basements, houses of one, two or three storeys of light or medium structure, the new type steel shelter.

With regard to the new steel shelters which had been designed by many members of the engineering profession and which were being produced with the co-operation of the steel industry, production had already begun and the supply would soon come forward in rapidly increasing rate. They had been constructed of very strong corrugated steel sheets, and when erected would take the weight of any débris that might fall on them from a house of the type for which they had been constructed. One of the shelters, the other day, withstood from 30 ft. the explosion of a 500-lb. bomb. The Government had decided that the distribution of the shelters should be made in the first place to householders who could not be expected to pay for them—persons whose occupations were compulsorily insurable under the National Health Insurance Act—then persons not compulsorily insured who were mainly dependent on earnings or pensions not exceeding £250. Outside that class there was a very large number of houses to which the shelter could have no application, and here the alternative of strengthening basements must come into play. There was in course of preparation a group of alternative designs for the strengthening of these basements, and the intention was to acquire centrally quantities of standardised strutting material, and in co-operation with the local authorities to arrange for the strengthening of those places. The cost would be in the neighbourhood of £20,000,000. This service would be entirely removed from the local authorities in order that they could concentrate their energies on communal shelters. The Government believed that in the space of relatively few months this policy would give the householders and their families in the vulnerable areas protection against the effects of blast, splinters and débris, which were responsible for the great majority of casualties from high-explosive bombs and from the effects of falling shell fragments from anti-aircraft guns.

Questions in the Commons.

In the House of Commons, MR. MCENTEE asked the Lord Privy Seal if local authorities in the Greater London area which were in the danger zone and where steel shelters were now being supplied were given any discretion in regard to supplying free shelters to persons whose income was above £250 per annum, and what was the limit of such discretionary power.

SIR J. ANDERSON said that initial distribution of steel shelters would be limited to those persons who, on what in the view of the Government was a generous interpretation, were not in a position to provide protection at their own expense. Border-line cases would be dealt with later when the needs of the poorer classes had been met. Local authorities would confine this initial distribution to the classes of persons indicated in the circular which had been issued to them; but these classes were not limited solely to persons with an income of under £250. All manual

Concluded at foot of previous column.

TRUSCON'S CONTRIBUTION TO A·R·P

We give below brief details of our recommendations for standard types of shelters which have been specially designed by our A.R.P. Department. Each design utilises our standard products, thereby incorporating the valuable benefits of our long practical experience, organisation and modern manufacturing methods. Construction is simple and speedy and can be carried out by local labour. Where shelters are required which are not met by these standard types, the full co-operation of our skilled designing and engineering staff is at your service.

STANDARD TRENCHES

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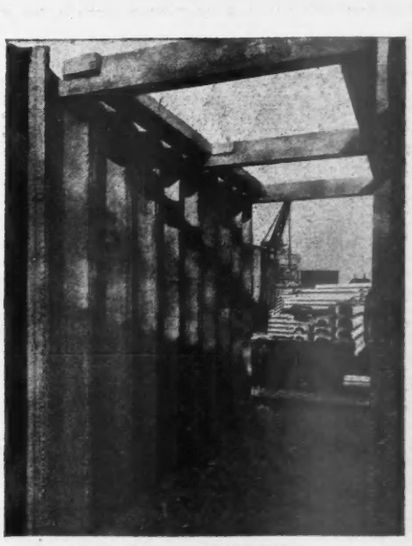

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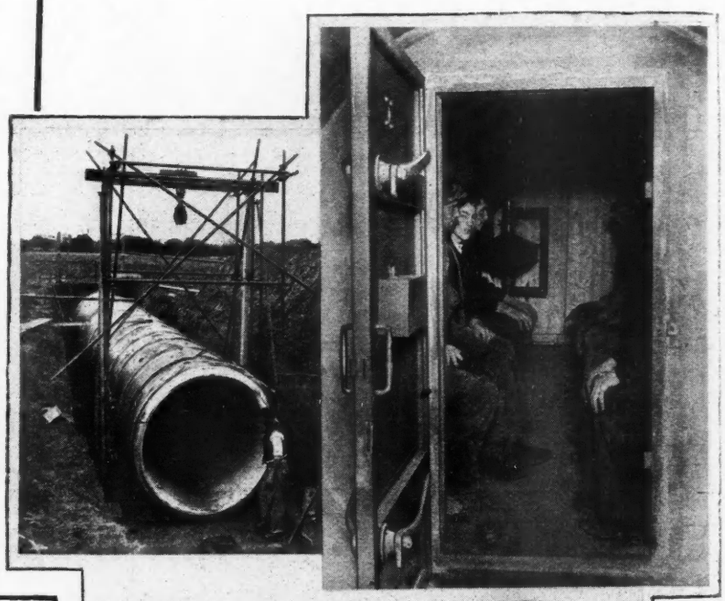

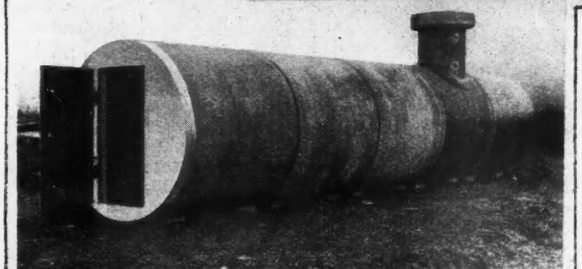

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National Camps for Evacuation.

A C.P.R.E. Memorandum.

THE Council for the Preservation of Rural England has issued the following memorandum on National Camps:—

1.—The statement made by the Lord Privy Seal on February 13 makes it clear that the Government have adopted a policy—and are actively preparing a detailed scheme—for the provision of a considerable number of National Camps which would be:—

(*a*) Built and owned by an *ad hoc* central National Camps Corporation (one for England and Wales and one for Scotland) relying on Treasury finance;

(*b*) used in event of war by the Ministry of Health's evacuation organisation as evacuation camps to accommodate children and other persons "non-essential to a war economy" evacuated from the large towns and other danger areas;

(*c*) rented and used under peace conditions either (1) by education authorities as camp-schools; or (2) by approval non-profit-making or public utility organisations as holiday camps for the rapidly increasing body of workers, with their families, who are obtaining holidays with pay.

SOME GENERAL CONSIDERATIONS.

2.—The scheme will presumably also make provision for a comprehensive survey of other camps, existing and projected (including camping or building sites equipped with services but with few or no permanent buildings), so as to determine the amount of suitable accommodation they would provide, whether fully or partially equipped, for evacuation use. We hope that it would also provide, in view of the obvious risk of speculative interference, for comprehensive Government control of the regional distribution, purchase and development of all camp sites throughout the country, so as to ensure that they are used to the best purpose, without inflation of land values and with due regard to evacuation use.

3.—We welcome and support all the three objectives—evacuation camps, camp-schools and holiday camps—covered by such a scheme and consider that, at the present juncture, all three purposes would best be served by concentrating the initiative and the available financial backing of the Government on a single national scheme organised on the lines indicated above. Apart from other considerations, central planning and ownership-control seems essential to secure maximum efficiency for evacuation use.

4.—We have no precise information as to total numbers or regional distribution of the children and other persons "non-essential to a war economy" whom it would be desirable to evacuate in event of war; but the available estimates and population statistics seem to indicate that the total number is of the order of 7 to 8 millions. It is manifestly impossible that billets could be found for the whole of such a vast number without excessive dislocation and overcrowding, involving serious danger to the efficiency, health and morale of the nation. Thus the number of camps which would be of vital usefulness for evacuation is very large—indeed, for immediate purposes it is limited only by the available finance and by the maximum rates at which suitable sites could be found and secured, and camp buildings constructed, without excessive calls on available stocks of suitable building materials.

5.—On the basis of preliminary schemes and calculations put before us, we think it both desirable and practicable that the first programme of the National Camps Corporations should be for not less than the 50 camps envisaged in the Lord Privy Seal's announcement, each accommodating on the average about 350 persons under peace conditions (whether as camp-schools or as holiday camps) and from 700 to 1,000 persons under war conditions as evacuation camps. Estimates of costs vary considerably (as would actual costs according to the nature of sites and the availability of roads and services); but the average estimated all-in building cost (exclusive of land and furnishings) appears to be about £40 per person accommodated under peace conditions, or £20 per person under war conditions. Thus the overall cost of a first programme of 50 camps would be of the order of £1,000,000. Since the average annual output of new buildings in Great Britain has been about £250,000,000 for the last three years, the production of £1,000,000 worth of camps—even if concentrated into three months—would not have a dislocating effect on the building industry or the supply of building materials, if carefully planned.

6.—We would add two comments: (*a*) That we suggest such a programme only as a first instalment and anticipate that it could, and should, be repeated, several times over and as rapidly as possible, without any danger of excess capacity either for war-time or peace-time use; (*b*) that the contemplated expenditure, though considerable, would none of it be wasted if the scheme were skilfully devised; indeed, the rents derived from peace-time uses should pay interest and amortisation at Treasury rates on a very large part of the capital cost.

7.—Our special concern, as the Executive Committee of the Council for the Preservation of Rural England, with any such scheme of camps (indeed with all kinds of oganised semi-permanent camps, whether within or outside a national scheme) is that they represent a new form of development which, if soundly located and well sited and designed in suitable materials, will serve vital national purposes while doing little or no damage to the landscape beauty, the farming efficiency and the general amenities of the countryside; but which, if badly located, sited and designed, will do widespread damage and, in all probability, serve their immediate purposes less efficiently. It is, we trust, unnecessary to stress that the preservation of rural Britain, as the source of food and water supplies, as the home of the rural population, and as the means of health-giving recreation for the urban population, is one of the most fundamental of long-term national requirements, and must, therefore, be a major controlling factor in any national camps scheme. We believe, however, that there need be no conflict between the various practical requirements of a lage number of camps and the requirements of countryside preservation, provided the scheme is skilfully devised and executed, with both ends constantly in view.

LOCATION, SITING AND DESIGN.

8.—We hope that it may be of service to set out briefly some observations on the location, siting and design requirements of the type of camps required under the scheme here suggested (*i.e.*, camps built for the dual purpose of (*a*) evacuation and (*b*) either school or holiday use). Time has not permitted more than a very rapid and preliminary examination of the matter, and our observations should not be regarded as more than provisional and general suggestions.

(a) Distribution and Location.

(1) It is desirable that the first programme (whether for 50 camps or some smaller or greater number) should be widely distributed over the country, so as to enable a regional organisation, to be built up on the basis of practical experience. While all or most of the camps in the first programme would thus be widely separated, consideration should be given to the possibility of future grouping of two or more camps fairly close together, so that they can share a single hospital unit and other common services.

(2) For evacuation use it is clearly essential —and for school and holiday use it is very desirable—that all camp sites should be definitely "in the country," well removed from any large towns and other danger areas or military objectives. Sites should, however, be relatively easy of access from the urban areas whence the camp occupants will be drawn, whether under peace or war conditions. In general, sites should not immediately adjoin either a main road or railway, but they should have direct and reasonably short connection to one or both. It would usually be an advantage that a site should be fairly near to a village, so as to secure an initial provision of shopping, public transport, etc., facilities and of social organisation.

(3) A pure and ample water supply without excessive cost is a first and critical requirement which will severely limit the choice of sites in many areas. Reasonably dry ground for the buildings and their immediate surroundings, with easy and reliable surface-water drainage and the possibility of efficient and economical sewage disposal (normally to the camp's own septic tank) are also of major importance. Connection to a public electricity supply, without excessive lengths of new transmission cables, would be an advantage.

(4) Sites should be chosen so that the buildings can be conveniently arranged on them without becoming conspicuous targets from the air; thus they should preferably be in well-timbered or, failing that, broken country (see also under Size and Grouping). Special care should, however, be taken in selecting sites in densely forested areas, especially where there are young conifer plantations, since the presence of school children and adults on holiday must tend to increase the risk of forest fires. In all such cases, the Forestry Commission should be consulted.

(5) Every effort should be made to avoid taking high-quality farm land for camp sites, and any unnecessary dislocation of farming operations. It is realised that any site is likely to form part of a farm of some sort, but choice should be confined as far as possible to low-grade pasture land and rough grazings. Where a site forms a substantial part of a farm it will usually be best to purchase the whole farm and re-let the surplus after necessary adjustments.

(6) Sites should be of ample size (see also below under Size and Grouping) and a substantial area surrounding each actual camp site should be protected, either by purchase or by convenant, against development. This is essential, not only to reserve space for possible expansion and for playing-fields, but also to prevent disfigurement by a sporadic development of bungalows, etc. (which tends to happen near any camp), and to maintain the country quality which is a large part of the camp's *raison d'être* for either school or holiday use. Proximity to some reasonably level open land available and suitable for playing-field use, and facilities for safe bathing (whether in sea or fresh water) are desirable features.

(7) Vulnerable parts of the coastline are obviously unsuitable for camps, but sites in other coastal areas would be suitable and, indeed, specially popular for holiday use. It is, however, of vital importance that the finer stretches of coastline which still remain unspoilt by development should be strictly preserved; the siting of camps in such areas should be avoided as far as possible, but if it is found essential, they should normally be placed at some distance back from the actual coast, and both siting and design should be most carefully considered from an amenity point of view. A list of coastal areas in England and Wales whose preservation is particularly important is given in the attached Appendix A.

(8) The same considerations apply to inland areas of special landscape beauty, particularly the larger stretches of wilder country which are the nation's potential National Parks. Sites within such areas (of which the most important are listed in the attached Appendix B) should be avoided (both on amenity

grounds and, in all mountain and moorland areas, on account of the heavy rainfall and severe winter conditions) unless there is a very strong reason for their choice. Most of such areas have, however, extensive belts of open, but less wild, country at their edges; there is no objection to camps being placed in these surrounding belts —where they would indeed be specially well placed for holiday use—provided siting and design are carefully considered from an amenity point of view.

(9) It will not be possible to use any common lands, properties owned by the National Trust, public open spaces, or lands on which building is prohibited by covenants with the National Trust or with planning authorities, without new legislative powers which it does not appear necessary or desirable to obtain. The National Trust should be consulted about any proposed site near one of their properties, and the Commons, Open Spaces and Footpaths Preservation Society about any proposal affecting common lands.

(b) Size and Grouping.

(1) The size of camps will obviously vary according to the requirements of the alternative uses and the scope of the individual site. On a balance of considerations, sizes accommodating 300 to 500 persons for school or holiday use and 700 to 1,000 persons for evacuation use seem to be a suitable range. A much larger camp would probably throw an undue strain on the resources and balance of a particular village or rural area and do harm to local amenities; on the other hand, a much smaller camp would probably be uneconomic in management and maintenance.

(2) In the general disposition of buildings, the appropriate means must be found between close concentration, which would increase both air raid and normal fire risks, and wide dispersion, which would usually involve inconvenience in use and management and a haphazard appearance damaging to amenities. The density, under evacuation conditions, probably should not exceed 100 persons per acre, which would give a minimum net building site of about 10 acres; on the other hand, dispersion over a building site of more than 20 acres would normally be excessive. At least 10 acres as reserve for possible expansion and for playing-field, etc., use should be added wherever possible; thus the full sites should range from 20 to 35 acres according to circumstances.

(3) The grouping of the buildings on each selected site must be carefully planned by a competent town planner or architect to suit its configuration, approaches and surroundings. Any tendency to standardisation of layout should be avoided. Each layout should be studied on the spot to make the best use of the site from all points of view—convenience, health, amenity—both of appearance and outlook—and concealment from air attack. Regular and symmetrical planning has not special advantages and is likely to make concealment difficult, but exaggerated and meaningless irregularity should be avoided. Advantage should be taken of trees, hedges and other features to break up and screen the camp not only from air-view, but also from ground views at any distance. Building on a sky-line or in other prominent positions should be avoided. All unnecessary urbanisation, as for instance by formal types of fencing, kerbing and paving, should also be avoided.

(4) It may be possible in some cases to centre a camp-site on an empty country house. Considerable numbers of such houses, too large or too out of date for the present-day demand, are available at very low prices and many of them would provide, after minor adaptation, a most useful nucleus of accommodation, already equipped in most cases with water supply and other services.

(c) Construction and Design.

(1) If the camp buildings are properly located and grouped in areas well removed from special risk of air attack, it will be unnecessary and unduly expensive to make them specially proof against blast and splinters. On all grounds, therefore—cost, speed of erection, warmth and comfort, etc.—timber is the obvious choice for the main constructional material. This choice would not rule out the use of steel framing, brickwork, concrete or other blocks, plastered expanded metal, asbestos sheeting, etc., if found convenient for a proportion of the camps. But where such materials are used for external surfaces, their colour should be carefully selected to harmonise with the locality. In particular, Fletton brickwork and concrete and other blocks should be colour-washed, with or without previous rendering.

(2) There would be great advantage in speed and cost if the buildings could, in general, be made of pre-fabricated units of convenient size (*e.g.*, wall panels including necessary door and window-frames of from 6 to 12 ft. unit length and appropriate floor-to-eaves height). Such units could readily be prepared in timber, for assembly on the site by simple bolting to each other and to the foundation raft or dwarf walls. All timberwork should be raised well clear of the ground on brick or concrete, with an air space under all timber floors. The timber wall units whether of open or solid construction would suitably be covered outside with vertical or horizontal weather-boarding (either in untreated Western Red Cedar or in creosoted redwood) and inside either with matchboarding or with some form of building board. Roofs should usually be of low pitch, gable-ended, and with eaves of ample projection. The roof colour should be most carefully chosen to suit the locality. A roofing material which should prove suitable in nearly all localities is Western Red Cedar shingles. Much can be done to improve the appearance of typical camp buildings by careful choice and application of white or bright coloured paint to doors, windows, etc.; but bright colours should be used with caution on any large surfaces.

(3) Standardisation should not be carried too far. Excellent for the constructional unit-section of wall or roof, it may easily produce inconvenience and ugliness if applied to whole buildings without a wide flexibility. It will probably be found desirable to prepare standard designs for dormitory and sanitary blocks and other essential units, but these should be in several alternative forms and capable of radical adjustment to suit the requirements of particular sites and circumstances. A thoroughly competent and skilled architect should be given full responsibility and wide discretion for the layout and design of each individual camp.

(4) Dormitories with movable beds and lockers are the most economical form of sleeping accommodation for camp-school use. Extra accommodation for evacuation use can conveniently be arranged by having beds which can be "stacked" in two tiers, a reserve supply being kept to make the second tier. Holiday camps will normally require their accommodation in separate single or double rooms; these could be provided either by inserting partitions (preferably removable) in dormitory units of camp-school type or (at greater cost) in detached or semi-detached chalets. In addition to sleeping quarters each camp will require either classrooms (for camp-schools) or common rooms (for holiday camps), a dining- and entertainment-hall, kitchens, sanitary blocks, store rooms, staff quarters, etc. All such accommodation, together with the heating, sewage disposal, etc., plants, must be designed to suit both the peace-time use and the possible evacuation use, involving an increased—probably doubled—population. Consideration should be given to the possibility of allocating part of the site to camping in tents, whether under normal or emergency conditions.

9. Finally, we would urge that the National Camps Corporation should secure effective consultation, on the location of camps and on the design of camp buildings (more especially as regards their arrangement on the site and their external appearance), with architects and other persons specially experienced in the requirements of countryside preservation. We offer our co-operation to this end in any way that may be found useful. In particular we suggest (*a*) that the Board itself should include at least one person with such special experience, and that others should be employed on its staff; and (*b*) that a central voluntary panel of architects should be formed to examine and report on the designs of all camps from an amenity point of view. We would be glad to help in finding persons who would possess the special qualifications required for such work, and who would be able to represent the views of all the national organisations concerned with countryside preservation.

APPENDIX A.

List of the most important Coastal Areas in England and Wales in which special care should be taken in the location, siting and design of camps.

(Note: This list should not be regarded as exhaustive.)

Northumberland.—Northern Section including Holy Island.

Yorkshire.—All substantial undeveloped stretches between Saltburn and Flamborough Head.

Norfolk.—Undeveloped stretches between Hunstanton and Sheringham.

Dorset.—Poole Harbour to Bridport (except near Swanage and Weymouth).

Devon and Cornwall.—All substantial undeveloped stretches.

Somerset.—Devon border to Minehead.

Glamorgan.—Gower Peninsula.

Pembroke.—All undeveloped stretches.

Cardigan.—Cardigan to Aberystwyth.

Merioneth.—North of Barmouth.

Caernarvon.—Undeveloped stretches of Lleyn Peninsula.

Anglesey.—North and west sides of Anglesey and Holy Island.

APPENDIX B.

List of the most important inland areas in England and Wales in which special care should be taken in the location, siting and design of camps.

(Note: This list should not be regarded as exhaustive.)

Northumberland and Cumberland.—Cheviot Hills (upper parts); surroundings of Roman Wall.

Cumberland, Westmorland and Lancashire.—The Lake District.

Durham, Westmorland, Yorkshire, Lancashire, and Derbyshire.—The Pennines (all moorlands and upper valleys, especially Whernside, Ingleborough and Penyghent area and the Peak District).

Yorkshire.—Cleveland Hills and adjoining moorlands.

Derbyshire and Staffordshire. — Dovedale and Manifold Valley.

Cheshire.—Delamere Forest.

Shropshire.—Clee Hills (upper parts); Long Mynd and Stiperstones Range.

Worcestershire and Herefordshire. — Malvern Hills.

Gloucestershire.—Cotswold Hills (upper parts).

Gloucestershire, Monmouth and Herefordshire.—Wye Valley from Ross to Chepstow.

Wiltshire and Berkshire. — Savernake Forest; Marlborough and Lambourn Downs (upper parts).

Oxfordshire, Buckinghamshire, Hertfordshire, Bedfordshire.—The Chiltern Hills (upper parts and escarpment where undeveloped).

Surrey and Kent.—North Downs (upper parts and escarpment where undeveloped).

Sussex and Hampshire.—South Downs.

Hampshire.—New Forest.

Somerset.—The Mendips (Cheddar Gorge and Blackdown areas); the Quantocks.

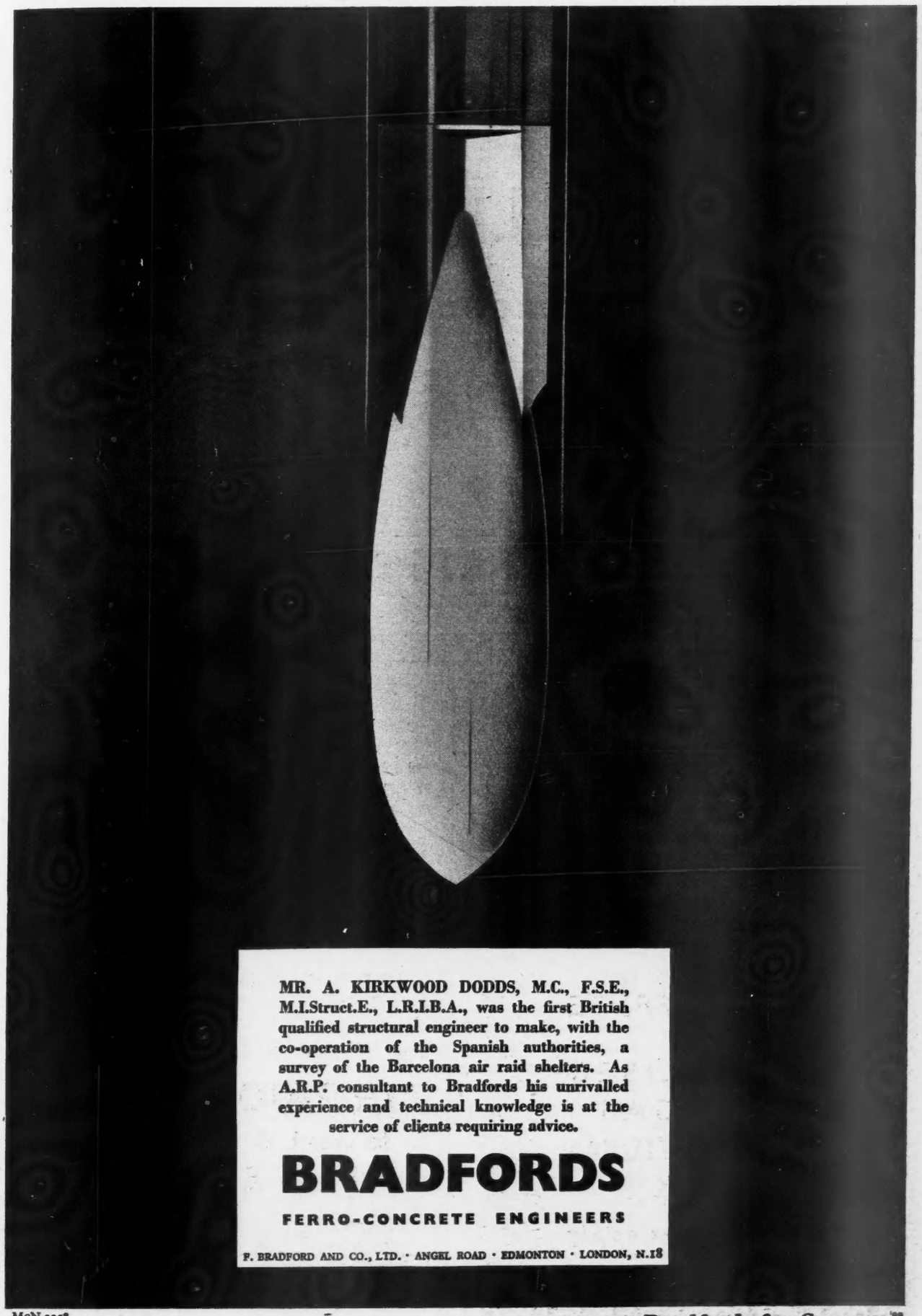
Devon and Somerset.—Exmoor.

Devon.—Dartmoor.

South Wales and Herefordshire.—Black Mountains; Brecon Beacons; Carmarthen Vans.

Mid Wales.—Plynlimon Group; Radnor Forest.

North Wales.—Snowdon Range; Merioneth Mountains.



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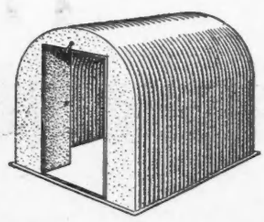

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A.R.P. Shelters.

To the Editor of *The Builder*.

Sir,—No doubt many of your readers have been interested in the exhibition of the models showing the proposed underground shelters to be built by the Metropolitan Borough of Finsbury.

I think congratulations are due to the Council of that borough on making what to my mind is the first practical contribution towards the bombproof shelter. I think it will be agreed that such a scheme may be called a long-term proposal and therefore cannot be accepted as a substitute for the measures the Government have adopted in providing the steel shelter for the individual house.

I was privileged to view the experiments made by the Home Office at Shoeburyness during the early part of last week, under practically air-raid conditions, of the standard steel shelter adopted by Sir John Anderson.

After reading the many criticisms as to what was likely to happen to a shelter so constructed, I was perhaps a little sceptical as to what the result might be. However, the experiment proved without any doubt that these criticisms are mostly unfounded.

After the explosion of a 500-lb. bomb placed within 30 ft. of the shelter, no damage whatever was caused to the shelter itself, although small portions of the earth covering the steel structure were slightly disturbed. I was convinced that as a short-term measure this type of shelter will prove to be a most practical and also the most economical form yet designed. Although it appears extremely simple in its parts, and easily erected by unskilled labour, the result has been obtained by much research and careful thought to produce for £8 very definite protection for a normal household.

While returning to town I realised more fully the practical value of this shelter. The sight of street after street of small houses, each containing a family for which protection *must* be provided, seemed a problem that can only be met in such a way.

The fact that the shelter so closely adjoins the home makes its usefulness of extreme value. It is not too much to say that with such provision the worker could leave his family with the confidence that they would be safe in his absence, which is a very material factor at such a time.

It is to be hoped that the country will realise now that Sir John Anderson has "delivered the goods" in this direction, as also in his decision to erect holiday camps. The sooner these two measures are an accomplished fact the way will be prepared for the adoption of some form of collective shelter. The collective shelter, by reason of its cost and the time for its construction, must be considered a work for the long-term policy.

This leads me to the Finsbury proposal, and I suggest a similar structure could be erected (at a very much reduced cost) above the ground, and could be made sufficiently blast- and bomb-proof as the structure proposed, which is inserted in the ground, and I would like to see the architects and engineers who have so ingeniously worked out their present scheme consider with the same energy and enthusiasm the raising of their cylindrical structure upwards instead of sinking it downwards.

The problem of the direct hit from the high-explosive bomb is the all-important factor. If the protective detonating "sandwich" of sand between two layers of concrete as suggested is sufficient protection against the high-explosive bomb, there can be no reason for inserting the cylindrical structure in the ground rather than above. It has been shown that a properly constructed ferro-concrete building, particularly if it is cylindrical in form, resists almost any blast from the high-explosive bomb.

The advantages of structures above ground would be: (1) Considerable saving in cost. (2) Increased speed of erection. (3) The omission of costly work in filters and air-conditioning, as natural ventilation could be provided above ground. (4) Simplification of the drainage problem. (5) Possibility of natural lighting during the day.

With regard to the suggested cost, does this sum include the purchase of the several sites required? If so, it would appear to be extremely low. Also, the time for erection (a very material point) of seven to eight months, surely must be under-estimated, unless overtime in probably three shifts is arranged.

The structure could then be so designed to have two basement floors normal in a City building, which could be used as a casualty station and hospital unit with operating theatre and decontamination centre shut off from the shelter, which would be immediately above.

Another feature which appears to me should be remembered is that at a time of stress it would be extremely difficult to restrict the use of these shelters, if they were effective, to persons residing in the borough. There would be a rush for safety, and this rush of terrified men, women and children would be down a sloping ramp 20 ft. in width, and in all probability result in the piling up of human beings, with a consequent panic.

If, on the other hand, the rush is upwards instead of downwards, greater control can be maintained. This is of great importance when the capacity provided only allows 6 sq. ft. per person.

The construction of a building above ground could be normal ferro-concrete construction on which a very large number of unemployed could be engaged, and further, the peace-time use of such a building would be much more valuable than the Finsbury proposal.

I make these suggestions not to detract from the very ingenious scheme described, but so that the points I have raised may receive consideration.

Stanley Hamp [F.R.I.B.A.].

126, Wigmore-street, W.1.

Asphalt and Mustard Gas.

To the Editor of *The Builder*.

Sir,—As there appears to be some misunderstanding in regard to the use of asphalt in relation to its resistance to mustard gas, due to statements which have appeared in certain publications, the Council would like to summarise the position as to the suitability of asphalt in connection with structures where air-raid precautions are being considered, and also the use of the material for general purposes.

It has been officially stated that:—

1. *Except in special buildings where anti-gas measures are conducted*, the various grades of asphalt normally employed in everyday work may still be used in buildings where air raid precautions are being considered.

2. In situations, and in particular floors, where in the event of war frequent decontamination from mustard gas might be necessary, a specially prepared asphaltic mix is recommended.

This grade of asphalt, which has been approved by the Air Raid Precautions Department of the Home Office for use under such conditions, is available from members of the Council.

It is interesting to note that asphalt used in general work is resistant to any known form of incendiary material likely to be used in warfare, and it is therefore unnecessary, excepting in certain specialised cases, to provide further protection to the roofs of buildings against fire.

The Council will be pleased to give any additional particulars with regard to this important matter upon application.

G. J. Hancock, Secretary,
The National Asphalte Mine-Owners and Manufacturers Council.
Terminal House,
Grosvenor-gardens, S.W.1.

LOCAL AUTHORITIES' A.R.P. SCHEMES

Many local authorities have prepared, or are in course of preparing, A.R.P. schemes. Following are brief details:—

ACCRINGTON.—Plans for a refuge beneath the new market in the centre of the town have been submitted to the Home Office.

BARNSLEY.—The T.C. have adopted the principle of a scheme expected to cost £50,000 for hollowing-out car parks and pedestrian subways under the squares and streets.

BATTERSEA.—It has been recommended that the B.C. accept the tender of Wates, Ltd., 1258, London-road, Norbury, S.W.16, at £7,084 14s. 8d., to line permanently trenches with concrete.

FINSBURY.—The B.C. are recommended to adopt a scheme for bombproof shelters at an estimated cost of £1,269,160.

FULHAM.—The B.C. are recommended to make application to the Home Office for approval to an expenditure of £440 for the provision of a cleasing station at Swan Wharf, for A.R.P. purposes and for approval to an expenditure of £178 for the provision of a cleansing station in connection with the extension of the refuse destructor, for A.R.P. work.

GOSFORTH.—The U.D.C. is to build A.R.P. headquarters and an auxiliary fire station consisting of a steel and wood frame building 116 ft. by 40 ft. with asbestos covering to walls and roof. Mr. Clifford Wild, surveyor, Council Offices, Gosforth, Newcastle, has prepared the plans.

GREENWICH.—It has been recommended that subject to the necessary consents being obtained the work of completing the construction of certain trenches be carried out at an estimated cost of £18,000.

ISLINGTON.—The B.C. have been recommended to spend approximately £10,225 on A.R.P. Schemes provide for a decontamination shed, portable shelters, excavation and equipping of dug-outs at three sub-stations, duplication of telephone exchanges, etc.

PADDINGTON.—The B. C. are recommended that tenders for making permanent the trenches in the Recreation Ground, Paddington Green and at the rear of the Town Hall be invited from about six selected firms.

SUNDERLAND.—A scheme for the provision of air raid shelters to cost over £500,000 has been approved in principle by the A.R.P. Sub-committee. The scheme provides for six miles of tunnels, 30 ft. below ground, and four large underground car parks.

SUNDERLAND. Sunderland and South Shields Water Co., John-street, have submitted to the Home Office a £15,000 scheme for protecting water supply from air raids.

TOTTENHAM.—The B.C. are seeking Home Office permission to make themselves responsible for the erection of the free household shelters. Plans are being considered for deep shelters at points along the main roads and for a central underground car-park shelter.

SPECIALIST SHELTERS AND MATERIALS

FIREPROOF PARTITIONS.

The popularity of light-weight fireproof partitions will undoubtedly receive an impetus in view of the risk of fire due to incendiary bombs in time of war, and this is particularly the case when the material has the added advantages of insulating noise and heat and cold. A partition claimed to be of this type, known as "Kimoloboard," and made by Cellactite and British Uralite, Ltd., of 296-302, High Holborn, London, W.C.1, is already in use in Government buildings to the specification of H.M. Office of Works, and those interested will have an opportunity of seeing its fire-resistance demonstrated at the British Industries Fair, Birmingham. The demonstrations will be held on the ground between "B" car-park and the Exhibition building at 3 p.m. on February 28, and on March 2. This multi-purpose partition board works like wood—that is, it can be sawn and planed with woodworking tools, and it will take nails and screws; it can be painted or distempered; it is claimed to be vermin- and rot-proof, free from condensation, and not to warp or crack. Apart from the ordinary uses of a fireproof partition, this board is recommended in A.R.P. work for panelling roof chambers to trap incendiary bombs, so that such bombs falling on a building will burn themselves out in the roof space and not damage the rest of the structure. It is stated that a 1-kilo electron bomb will burn itself out on a sheet of "Kimoloboard" and yet only slightly damage the surface of the board. The material is supplied in sheets measuring up to 8 ft. by 4 ft., and in thickness from ¼ in. to 1 in. (Fig. 1).

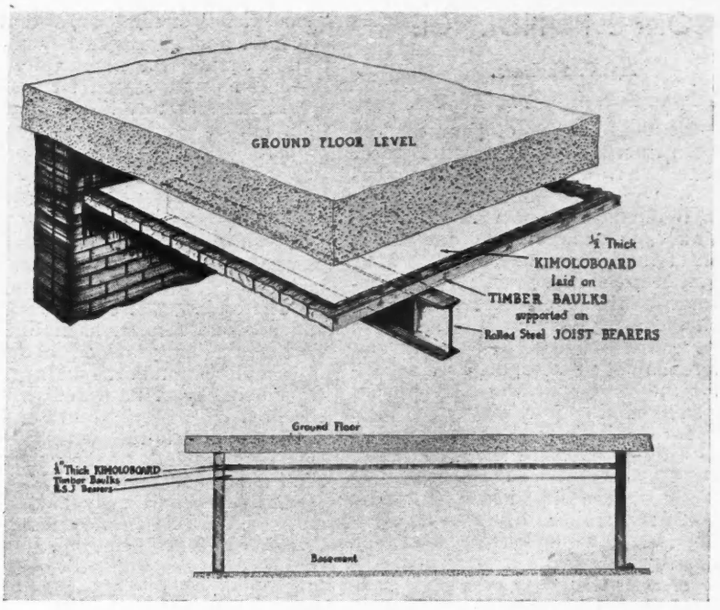


Fig. 1.—METHOD OF LAYING "KIMOLOBOARD."

A METAL-FACED PLYWOOD.

A material particularly suitable for wall linings and dressing and lavatory cubicles in decontamination centres is "Flexometal" (metal-faced plywood), manufactured by Messrs. Flexo Plywood Industries, Ltd., "Flexo" Works, South Chingford, London, E.4, who are also the manufacturers of "Flexo" flush doors, completely encased in steel, for gas-proof doors to air locks.

"Flexometal" is basically either a multi-ply or laminated plywood with a sheet of metal on one or both sides, cemented thereto with a special adhesive under high pressure. There are two types manufactured, one of which is used primarily where durability and weather resistance are required on only one face, and the other where durability and weather resistance are required on both faces of the panel or where a panel of maximum resistance to buckling and bending per unit of weight is required. The first type of "Flexometal" has one metal face and the second two metal faces. The steel facing of "Flexometal" is zinc-coated to resist rusting, and this, in turn, is chemically treated to hold paint. The steel facing is claimed to resist penetration in minor accidents, the plywood backing absorbing the energy of a blow, and thereby preventing the serious denting so conspicuous in the case of plain sheet metal. "Flexometal" is also claimed to have considerable value as a fire-retardant. While the red heat of a flame destroys the bond between the metal and the wood the latter continues for some time to insulate against the high temperature of the flame and thereby protects inflammable articles near the plywood surface.

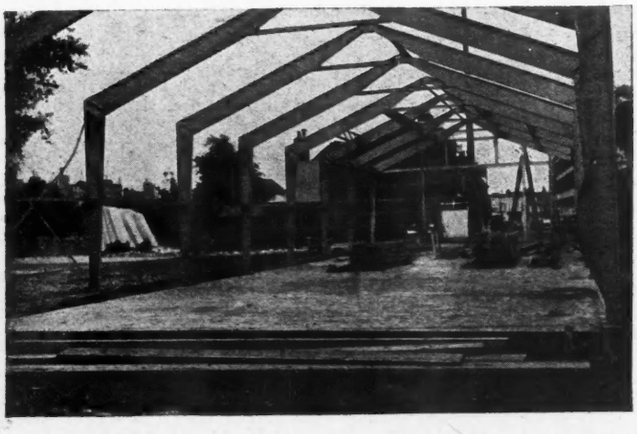
A NEW FIRE-EXTINGUISHING APPARATUS.

Messrs. Hypower, Ltd., 19, Hatfields, Southwark, S.E.1, announce their new hydro-chemical fire-extinguishing apparatus, designed for the automatic supply of chemical through power hydrants. The power supply is taken from the mains of the London Hydraulic Power Company. The manufacturers claim that this is a simple and inexpensive form of aparatus, fitted with instantaneous couplings, which may be particularly used for A.R.P. purposes. Features of special interest are: The chemical is automatically admitted into the supply main in quantity strictly proportionate to the flow of power through the same; owing to the simplicity of design there are no working parts to get out of order; and the chemical container can be fixed in any suitable position and is easily recharged.

RAPID CONSTRUCTION OF SECTIONAL STEEL BUILDINGS.

The accompanying illustrations show the light steel-frame building skeleton supplied by Light Steel Sectional Constructions, Ltd., of 170, Tarring-road, Worthing. These are particularly suitable for A.R.P. and other structures which have to be provided with great speed. The structure illustrated has been erected for the accommodation of auxiliary fire equipment and trailer-pumps for the Worthing Corporation; it comprises eight steel frames, and was erected by one man and one boy in one and a half days. Similar structures have been erected to form emergency casualty wards for the West Sussex County Council, and these can, of course, be used for stores, workshops, dormitories, offices, and any other purpose for which accommodation of this type is suitable.

The standard frames give an overall width of 19 ft. 6 in.; the height of the vertical sides is 7 ft. 9 in., and the height to the apex of the roof 11 ft. 9 in. The frames may be spaced from 5 ft. to 8 ft. apart to make a building of any desired length. Each frame comprises two stanchions and two roof members with a tie-rod, and has a total weight of 175 lb. Rag-bolts are used to hold the frames down to the foundation concrete, and wood insets are provided at suitable positions for fixing asbestos-cement sheets or other covering. Asbestos-cement or similar coverings can be fixed to both sides of the frames to form a cavity wall if desired. Advantages of this type of construction is the speed with which it can be dismantled, the ease with which the four parts of each frame can be stored, and the speed with which the frames and coverings can be re-erected. Such structures are claimed to be highly fire-resistant. (Figs. 2 and 3.)



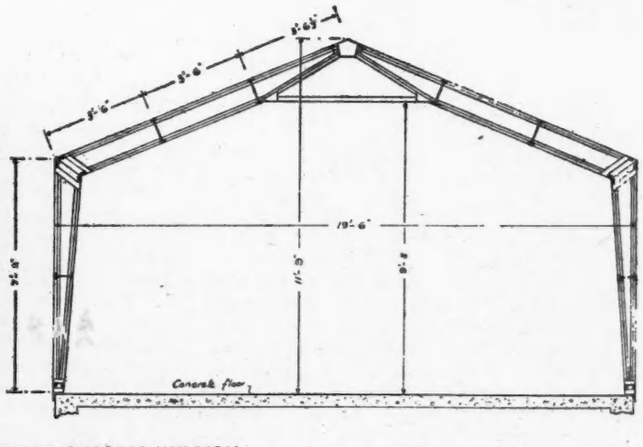
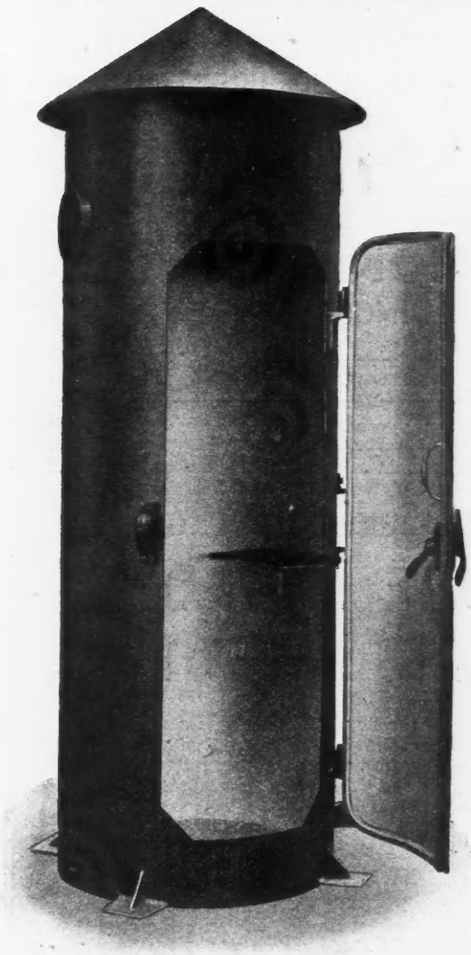


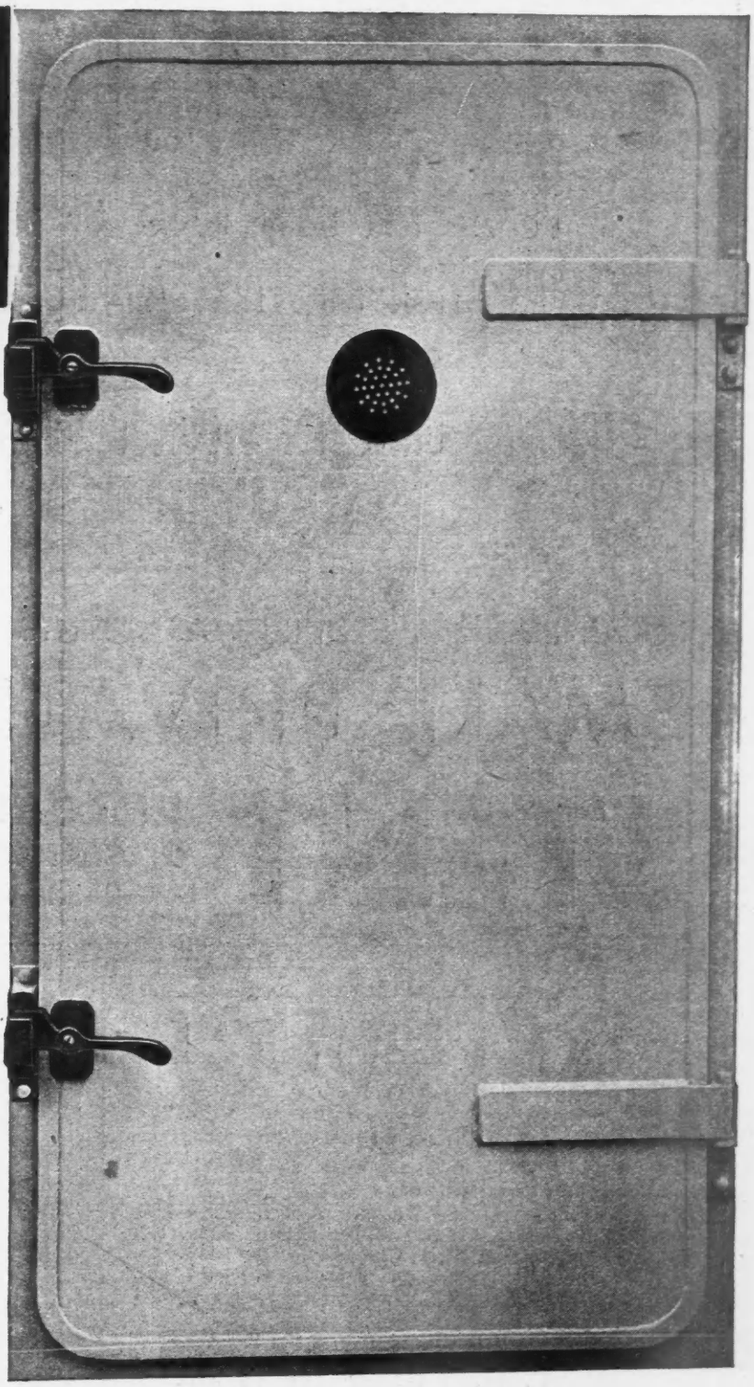
Fig. 2 AND 3.—A LIGHT STEEL-FRAMED BUILDING SKELETON.

A.R.P.

BOOTH

SPECIALITIES FOR AIR-RAID PRECAUTIONS





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ALL-WELDED STEEL GAS-TIGHT DOORS FOR A.R.P. SHELTERS

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PUBLIC and COMMERCIAL SHELTERS, TRENCH LINERS, DECONTAMINATION and FIRST AID POSTS, DRESSING STATIONS, etc.

STANDARD UNITS EX STOCK QUICKLY AND CHEAPLY ERECTED. SPECIAL TERMS TO BUILDERS.

LOCAL BUILDERS REQUIRED AS AGENTS FOR SALE AND ERECTION OF

SMALL PRIVATE SHELTERS

STENT PRECAST CONCRETE LTD.
2, CENTRAL BUILDINGS, LONDON, S.W.1
WHITEHALL 2573 (4 lines)

THE "ARPRODUCT"
Patents applied for

SHELTER

6 ft. x 4 ft. 6 in. x 6 ft. to Eaves.

For erection on or under ground level.

Holds 4 adults or 6 adults in emergency. Guaranteed (if properly erected) shatterproof, and against fear of collapse. Useful for tool sheds, etc. Built scientifically and purposely by Steel Manufacturers WHO KNOW. Can be erected by two persons in five minutes or by one person in fifteen minutes. There are no screws or nuts and bolts to tighten, all joints being keyed together.

Price complete, delivered your home in England or Wales, with simple erection instructions.

"ARPRODUCT No. 1" £5 12 6
CASH WITH ORDER

This price does not include steel sheets for sides, as you may have your own idea of these, such as sandbags, T. and G. boarding, etc.; they may be left open if subsoil is firm and suitable.

"ARPRODUCT No. 2" £6 10 0
CASH WITH ORDER

delivered as above, and including sheets for sides.

For extensions which are keyed together by the same easy method, and making the shelter as long as you wish **£2 16 3** per yard "No. 1" section, or **£3 5 0** per "No. 2" yard. One yard is sufficient space for 2 or 3 adults according to emergency.

Sandbags and paint can be obtained from us.

Orders dealt with in strict rotation.

Special Prices quoted for all local A.R.P. Committees, Schools, Works, etc., schemes.

We are prepared to quote and carry out complete job.

DUCTILE STEELS LIMITED

SHORT HEATH, WILLENHALL
(ON ALL GOVERNMENT LISTS)
MANUFACTURERS OF HOT & COLD ROLLED STRIP, BARS, STEEL SHEETS
'Phone: Willenhall 601 (5 lines). 'Grams: DUCTILITY, WILLENHALL.

War Damage to Property

STATE INSURANCE PLAN REJECTED

● The Chancellor of the Exchequer's proposal for compensation is limited to funds available *after*, not before war, when other interests have been served and *total* damage is assessed. Therefore the OBVIOUS SOLUTION is *still* the mutual scheme the Property Owners' Protection Association offers through its Associate War Risks Society. Tens of thousands, including the largest property-owning interests spread over the country, have taken advantage. A substantial fund has been established and invested in gilt-edged securities. Should no war occur within 9 years subscriptions plus interest are returnable.

● *ALL PROPERTY OWNERS SHOULD PROTECT THEIR INTERESTS BY BECOMING MEMBERS NOW.*

Forms and particulars from the Secretary.

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Fig. 4.

AIR RAID SHELTER OF DOVETAILED STEEL SHEETING; Fig. 4, INTERIOR VIEW. Fig. 5, EXTERIOR VIEW.

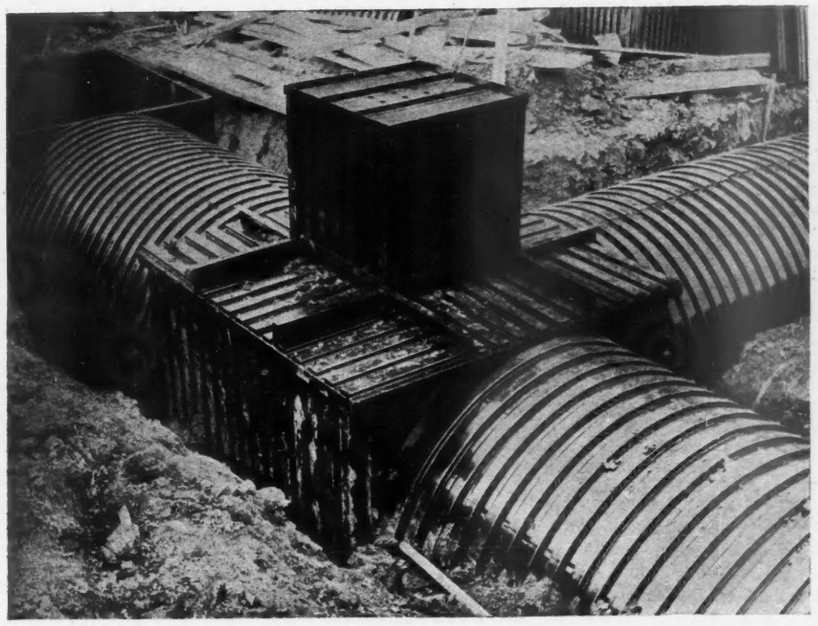

Fig. 5

REINFORCING UNITS FOR TRENCH LINING.

"Ribmet" reinforcing units for permanent concrete trench lining are recommended by the Expanded Metal Company, Ltd., Burwood House, Caxton-street, Westminster, S.W.1. The "Ribmet" is composed of ½-in. mesh "Expamet" expanded steel and V-shaped ribs attached to it, with wire clips or ties in the direction of the longway of the mesh of the expanded sheet. The meshwork is small enough to retain the concrete placed against it, and forms a "key" for the inside coating; the whole outside face of the "Ribmet" should be given ½-in. of sand and cement rendering as a minimum protective coat to it. The concrete should be mixed a little on the dry side. A unit consists of two sheets for the walls and roof slopes and a crown sheet, the ends of which are to be overlapped on and wired to the wall sheets. The standard units are 3 ft. 1½ in. wide and should be overlapped 1½ in. where they join at sides, leaving a net width of 3 ft., but making-up units can be supplied to suit any length of trench.

Among the advantages claimed for the units are the ease and speed with which they can be handled and assembled correctly in position.

TRENCH LININGS OF DOVETAILED STEEL SHEETING.

An air-raid shelter with a trench lining constructed from the "dovetailed" steel sheeting of Messrs. Steel Ceilings, Ltd., is now in course of erection at the Steleonite works of the firm at Hayes, Middlesex. The standard shelter trench lining is 5 ft. wide and 7 ft. 1 in. high, and is constructed of 16-gauge "dovetailed" steel sheeting; sizes other than this, however, can be supplied if required, whilst flooring constructed of "dovetailed" steel sheeting can also be provided.

The design of the trench lining, as illustrated, consists of 2 ft. wide sections of two lengths of hot bitumen-coated sheeting, curved at the top where they are interlocked into each other. The lower ends of the sheets are fixed in channels formed by two strips of pressed steel angle, spot-welded to a plate, correct positioning being ensured by tie-rods fixed at suitable distances to these plates. When the trench linings are in position, the top of the trench is filled in with earth to a depth of about 2 ft. or to such depth as that of the trench necessitates. Alternatively, the top may be covered with a suitable thickness of concrete, with earth again placed above this. (Figs. 4 and 5.)

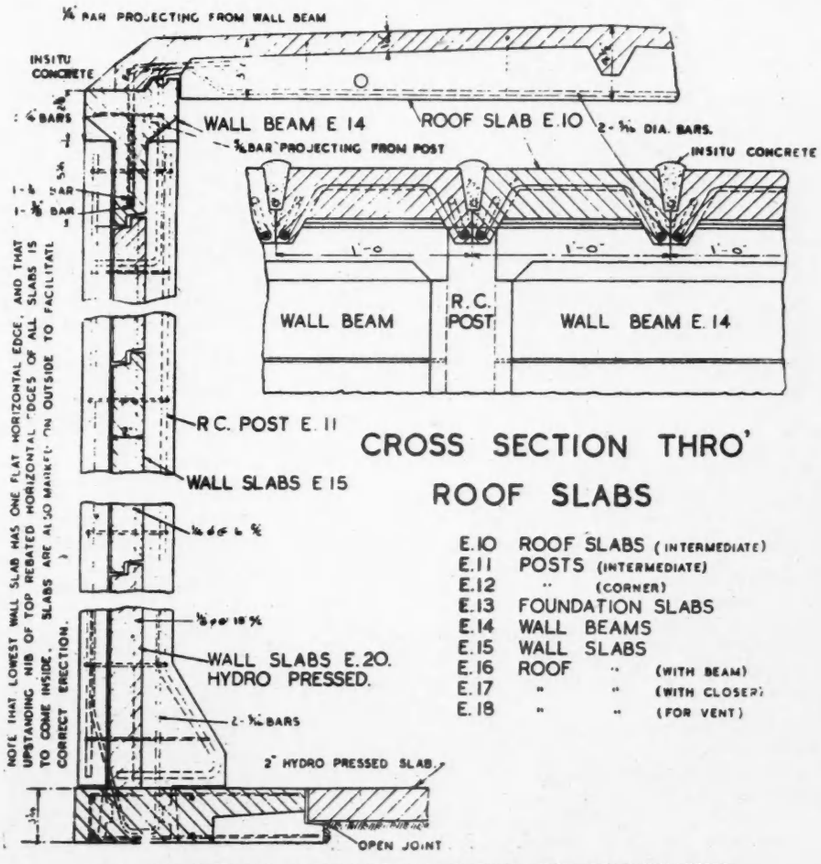
BAR PROJECTING FROM WALL BEAM
INSITU CONCRETE
WALL BEAM E 14
ROOF SLAB E.10
2-⅜ DIA. BARS.
⅜ BAR PROJECTING FROM POST
INSITU CONCRETE
1'-0
1'-0
1'-0
WALL BEAM
R.C. POST
WALL BEAM E.14
R.C. POST E.11
WALL SLABS E.15
WALL SLABS E.20. HYDRO PRESSED.
2-⅜ BARS
2" HYDRO PRESSED SLAB
OPEN JOINT
NOTE THAT LOWEST WALL SLAB HAS ONE FLAT HORIZONTAL EDGE, AND THAT UPSTANDING NIB OF TOP REBATED HORIZONTAL EDGES OF ALL SLABS IS TO COME INSIDE. SLABS ARE ALSO MARKED ON OUTSIDE TO FACILITATE CORRECT ERECTION.
CROSS SECTION THRO' ROOF SLABS
E.10 ROOF SLABS (INTERMEDIATE)
E.11 POSTS (INTERMEDIATE)
E.12 " (CORNER)
E.13 FOUNDATION SLABS
E.14 WALL BEAMS
E.15 WALL SLABS
E.16 ROOF " (WITH BEAM)
E.17 " " (WITH CLOSER)
E.18 " " (FOR VENT)

Fig. 6.—DRAWING GIVING DETAILS OF "BRITANNIA" TYPE E TRENCH LINERS.

Fig. 7.—A SHELTER OF INTERLOCKING PLATES, KENSINGTON, W

Shown above is part of a shelter for Kensington Borough Council constructed with interlocking concrete plates, which are subsequently bolted together. This is the "Impervious" Type F.

WATER-TIGHT TRENCH SHELTERS.

Stent Precast Concrete, Ltd., 2, Central Buildings, S.W.1, draw attention to their "Impervious" Type "F" air raid shelter, as used by the Kensington Borough Council, the first of the London boroughs to complete and make permanent their shelters. The firm also produce other types of shelter, but the "Impervious" Type "F" has been developed to obtain a water-tight shelter or trench liner largely to meet the requirements of Air Ministry. It consists of ribbed plates which firstly interlock, and secondly are bolted together, giving a rigid structure 4 ft. 9 in. wide inside plates and 4 ft. 11½ in. overall outside. For wet locations this type must be erected on an *in situ* concrete floor, but a paving flag floor is economic in ordinary soils. The joints between the ribs are grooved to receive cement grout when assembling and there is also a caulking groove at the inner face of the joint for caulking with bitumen to make them watertight even under pressure.

The different soil conditions obtaining and the method of jointing to get watertightness are as follows: (*a*) Normal damp soil: Cement grouting only; (*b*) Occasional rise of sub-soil water: Cement grouting joint as above, plus caulking of inner groove; (*c*) Standing sub-soil water and/or unstable soils (marshlands): As in (*b*) above with 4 in. concrete up wall outside to above water level, reinforced and bonded to concrete floor.

The units for stop ends, tee, elbow and cross junctions are standardised and the whole is easily and quickly erected. Every junction has provision for fitting a ventilator or emergency exit shaft as standard. If the shaft is not required the cover slab fits down direct on to the roof. (See Figs. 6 and 7.)

STEEL TROUGHED SHELTERS.

Messrs. Joseph Westwood and Co., Ltd., Napier Yard, Millwall, E.14, draw attention to their "Elephant" types of shelter, which, they state, were "supplied in thousands during the War to our own Government and those of the Allies." The "Elephant" type of shelter consists of curved steel troughing sections about 10 ft. long and 3 ft. wide, which have been specially designed for speedy erection. The manufacturers state that where trenches are used the flat type of troughing can be used and will carry a greater load than corrugated sheets, and go on to suggest that the curved type could be erected in such places as the London squares and open spaces, and earth or sandbags stored inside until required. A sample unit of these types of shelter is erected at Messrs. Westwood's works at Millwall. A brochure illustrating and describing the "Elephant" irons will be forwarded on request.

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GUIDE TO MATERIALS AND EQUIPMENT
FOR A.R.P. PURPOSES

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J. B. GRAVITY Ladder Co., Ltd.

AIR CONDITIONING.
AIR CONDITIONING CORPN. (JEFFREYS), LTD.

AIR FILTERS.
BRABY, Fredk., & Co., Ltd.

ASPHALTE.
"ANTIGASPHALT." LIMMER & TRINIDAD LAKE ASPHALTE CO., LTD.
EXCEL ASPHALTE CO., LTD.
FIELD & Palmer, Ltd.
PERMANITE, Ltd.

BARS, STEEL REINFORCING, FOR CONCRETE BOMB-PROOF SHELTERS.
MESH Steel.
ROM River Co., Ltd.
"TWISTEEL" Reinforcement, Ltd.

BASEMENT (STRENGTHENING OF).
ACROW (Engineers), Ltd.
BOULTON Tubular Structures, Ltd.
HIGGS & Hill, Ltd.
STEEL Scaffolding Co., Ltd.

BINS (DECONTAMINATION).
AIR CONDITIONING CORPN. (JEFFREYS), LTD.
BRABY, Fredk., & Co., Ltd.
BUTTERFIELD'S of Shipley.

CAMOUFLAGING.
FREEMAN, JOS., SONS & CO., LTD.
NICHOLLS & Clarke, Ltd.
SILICATE PAINT CO.
STEEL Scaffolding Co., Ltd.

CHECK ACTION FLOOR SPRING HINGES (FOR GAS-PROOF DOORS).
ADAMS, ROBERT
NICHOLLS & Clarke, Ltd.

CHEMICAL CLOSETS.
ELSAN CO.
NICHOLLS & Clarke, Ltd.

CONCRETE.
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LAFARGE ALUMINOUS CEMENT CO., LTD.

CONCRETE HARDENER.
CEMENTONE NO. 8. JOS. FREEMAN, SONS & CO., LTD.

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ELLIS, JOHN, & SONS, LTD.
GIRLING'S FERRO-CONCRETE CO., LTD.
INDENTED BAR & CONCRETE ENGINEERING CO., LTD.
SELF-SENTERING EXPANDED METAL CO., LTD.
STENT Precast Concrete, Ltd.
TRIANCO, LTD.
TRUSSED CONCRETE STEEL CO., LTD.
WALLIS, G. E., & SONS, LTD.
WATES, Ltd.
WRIGHT, SAMUEL, & CO., LTD.

CONCRETE STRONG ROOMS.
MILNERS' Safe Co., Ltd.

CUBICLES (LAVATORY).
FLEXO Plywood Industries, Ltd.

DAMP PROOFING.
ADAMITE Co., Ltd. "Colemanoid."
BRITISH Bitumen Emulsions, Ltd.
BYRD, A. A., & CO., LTD.
EXCEL ASPHALTE CO., LTD.
FIELD & Palmer, Ltd.
FREEMAN, JOS., SONS & CO., LTD.
GRANGERSOL, Ltd.
JONES, Jno., (Steel-Crete), Ltd.
KERNER-Greenwood & Co., Ltd., "Pudlo."
NEWTONITE, LTD.
NICHOLLS & Clarke, Ltd.
PERMANITE, Ltd.
R.I.W. Protective Products Co., Ltd.
RIGBY (London), Ltd.
SEALOCRETE PRODUCTS, LTD.

DECONTAMINATION PLANT.
BRABY, Fredk., & Co., Ltd.

DOORS (GAS-PROOF).
AIR CONDITIONING CORPN. (JEFFREYS), LTD.
BOOTH, J., & SON (BOLTON), LTD.
BRABY, Fredk., & Co., Ltd.
CASTON & CO., LTD.
FLEXO Plywood Industries, Ltd.
HAYWARDS, LTD.
SANDELL, JOS., & CO., LTD.

EXTENSION LADDERS
DREW, CLARK & CO.

FAN UNITS (FOR WALL PARTITIONS, SHELTERS).
GREENWOOD-AIRVAC: Greenwood's Ventilating Co., Ltd.

FIREPROOF FLOORS.
ATTOC BLOCKS, LTD.
KING, J. A., & Co., Ltd.
SMITH'S FIREPROOF FLOORS, LTD.
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FIREPROOFING MATERIALS.
CASEBOURNE & CO. (1926), LTD.
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FREEMAN, JOS., SONS & CO., LTD.
NICHOLLS & Clarke, Ltd.

FLOORS (REINFORCED CONCRETE).
ATTOC BLOCKS, LTD.
BRADFORD, F., & CO., LTD
SMITH'S FIREPROOF FLOORS, LTD.
UNEEK CONCRETE CONSTRUCTIONS, LTD.

GALVANISED CORRUGATED SHEETS.
BRABY, Fredk., & Co., Ltd.
MERCER, SAMUEL, & CO.
NICHOLLS & Clarke, Ltd.
WESTWOOD, Jos., & Co., Ltd.

GAS FILTRATION CELLS.
AIR CONDITIONING CORPN. (JEFFREYS), LTD.

GAS FILTRATION & VENTILATION.
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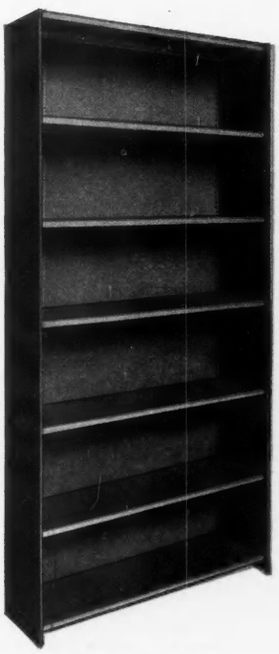

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ORIGINATORS OF THE ALL-STEEL ADJUSTABLE PROP

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1. When inner tube is fully extended (2' 0") its holes are well below the top of the outer tube, thus giving maximum strength at junction of tubes.

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3. Splayed foot is supplied with long plain guide above thread to ensure no bending at root of thread.

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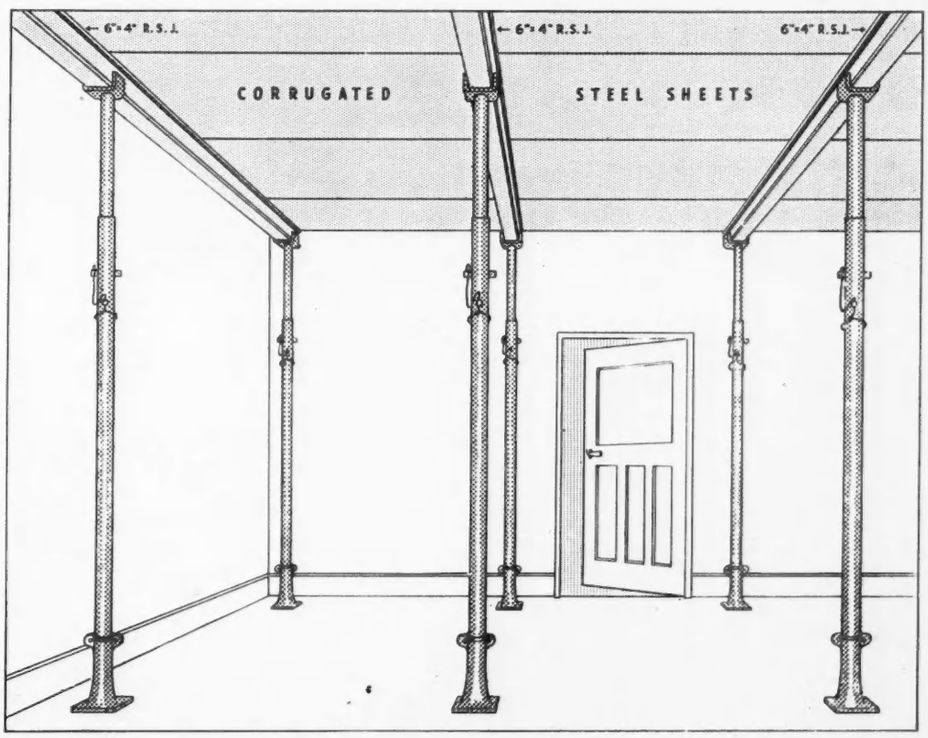

Sketch showing ground floor slab strengthened by Acrow Special A.R.P. Props supporting re-inforcing joists under corrugated steel sheeting.

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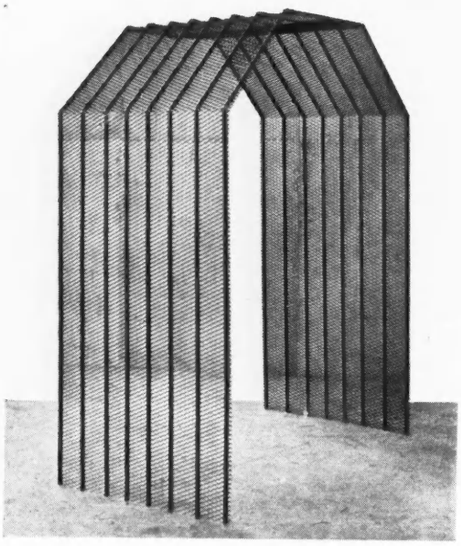

A single Unit of "Ribmet" Reinforcement and Permanent Centering for Concrete Trench Lining.

View showing temporary collapsible strutting in position for concreting.

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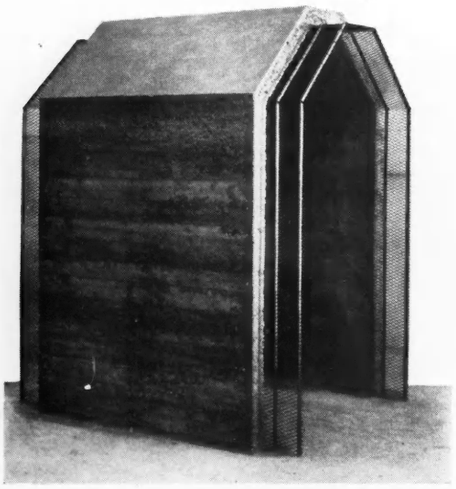

Section of Trench concreted and rendered.

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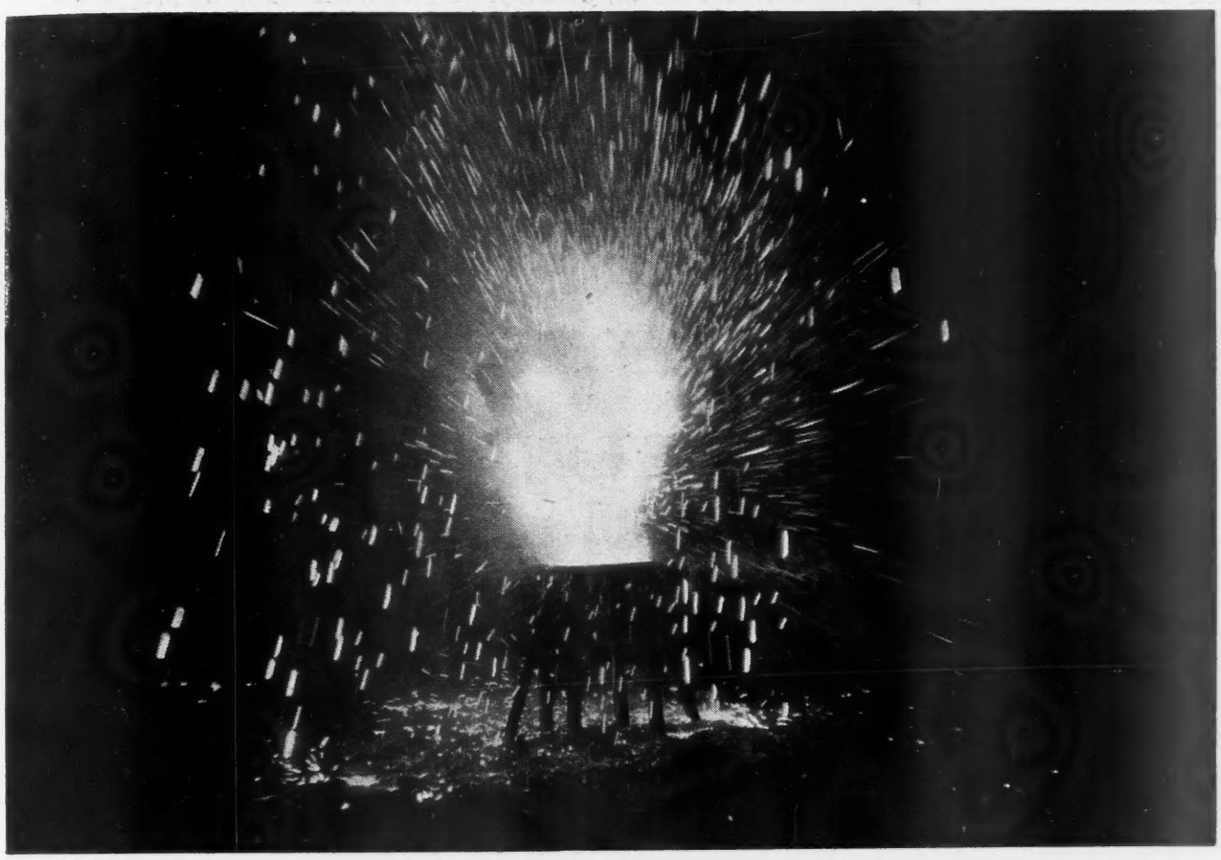

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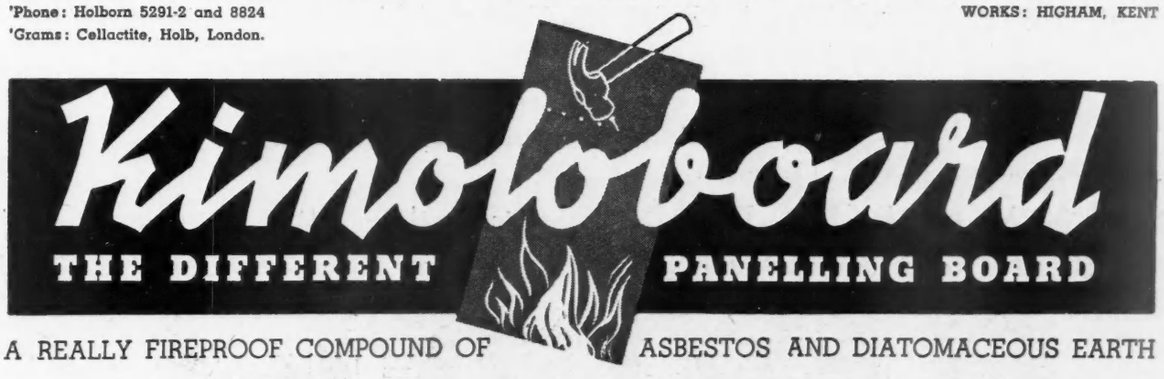

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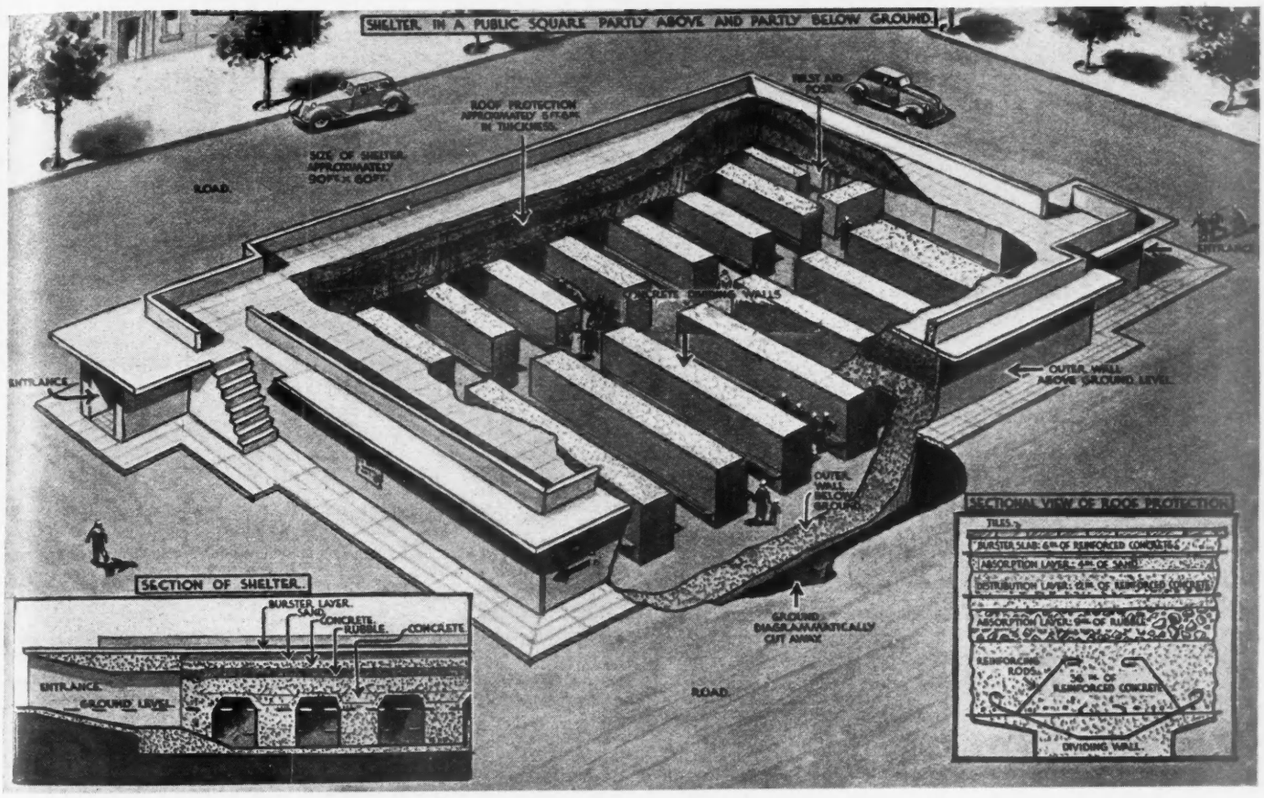

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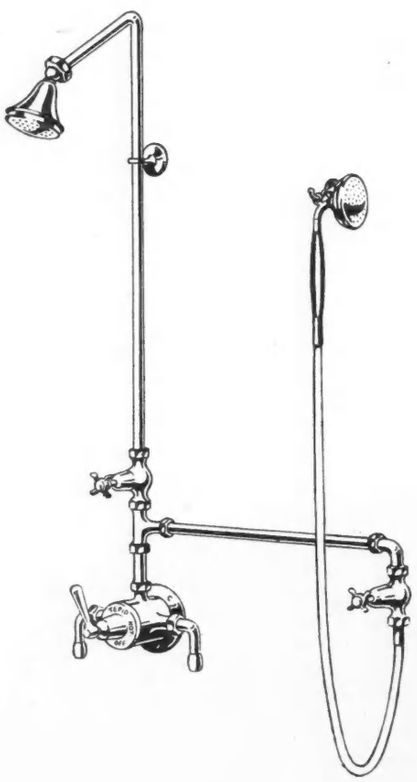

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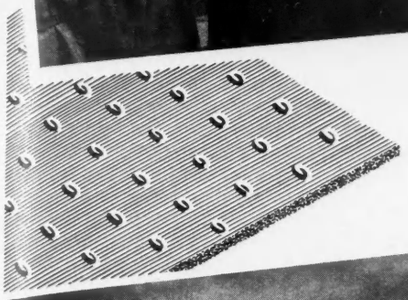

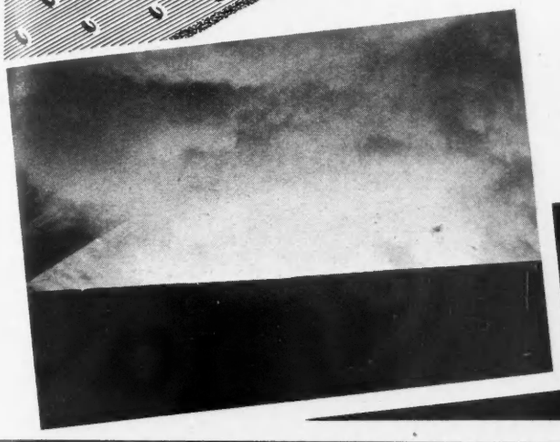

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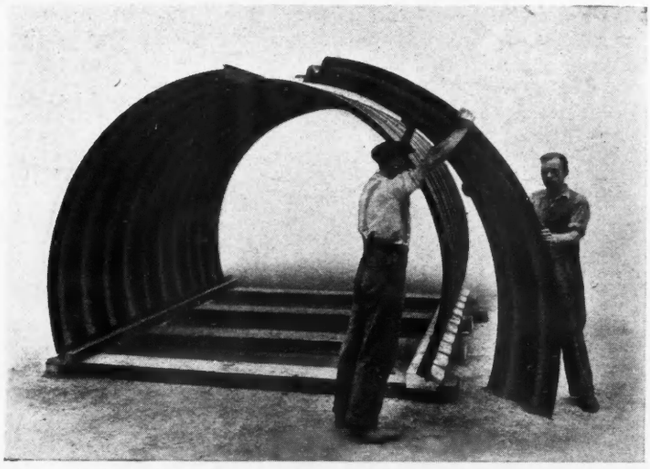

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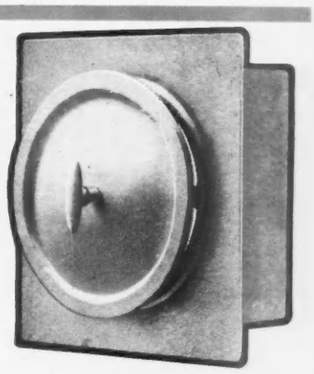

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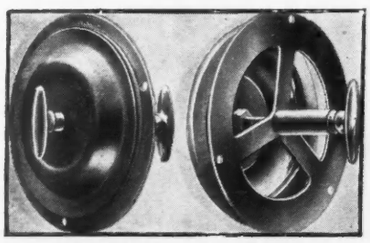

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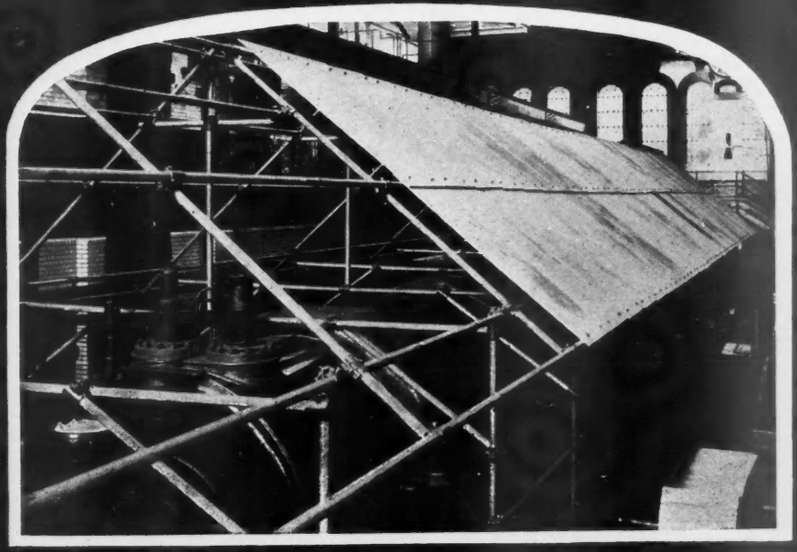

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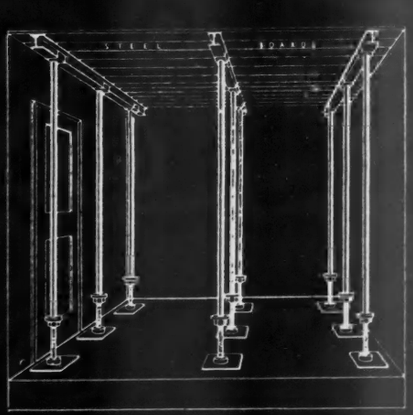

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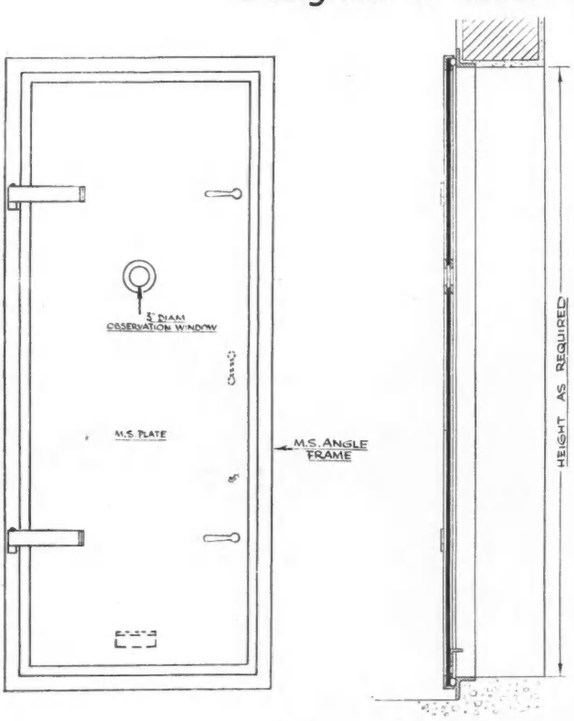

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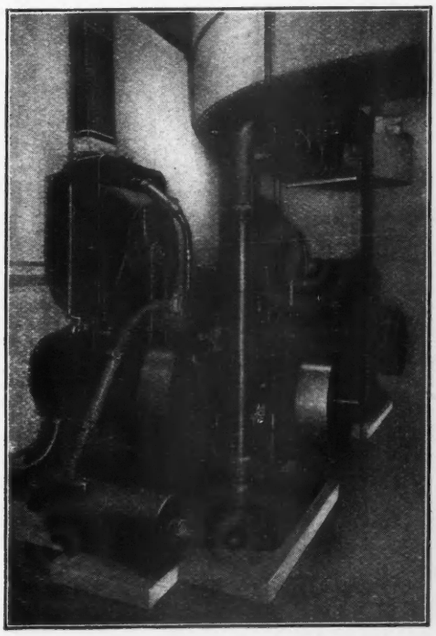
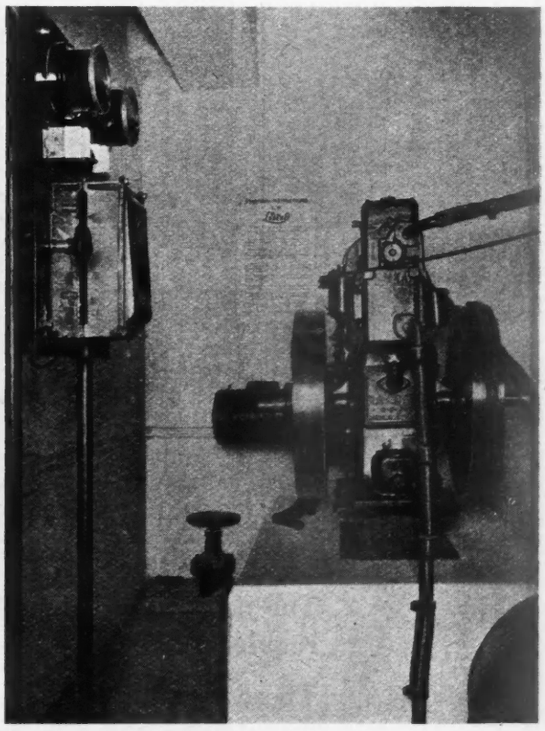


Photo The Oil Engine



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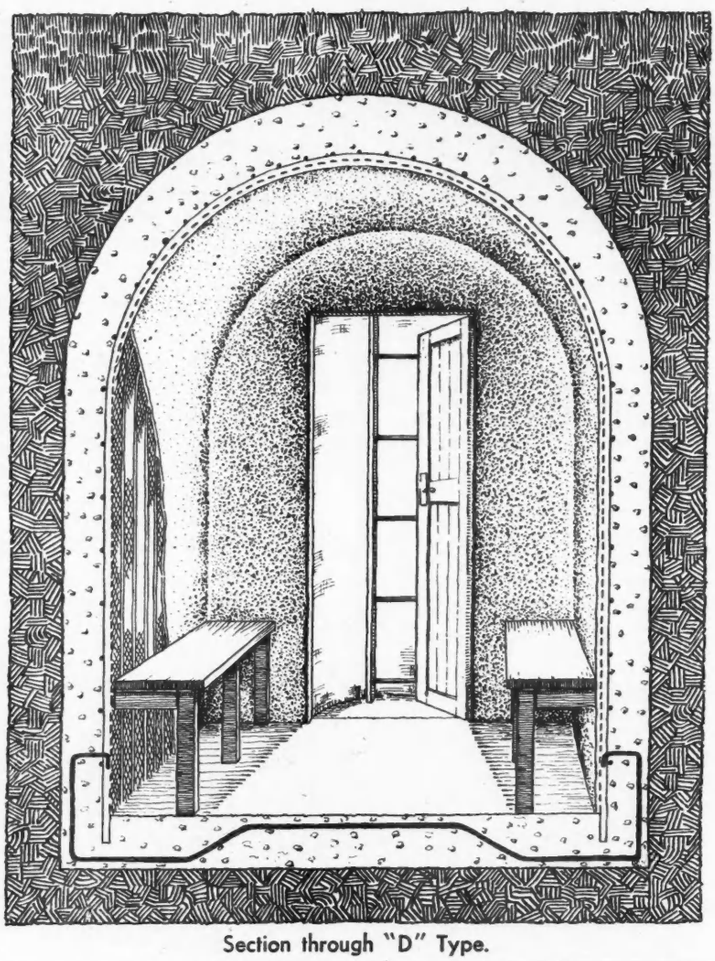

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"C" Small—conical in shape—for open ground away from Buildings—to accommodate 6 persons.

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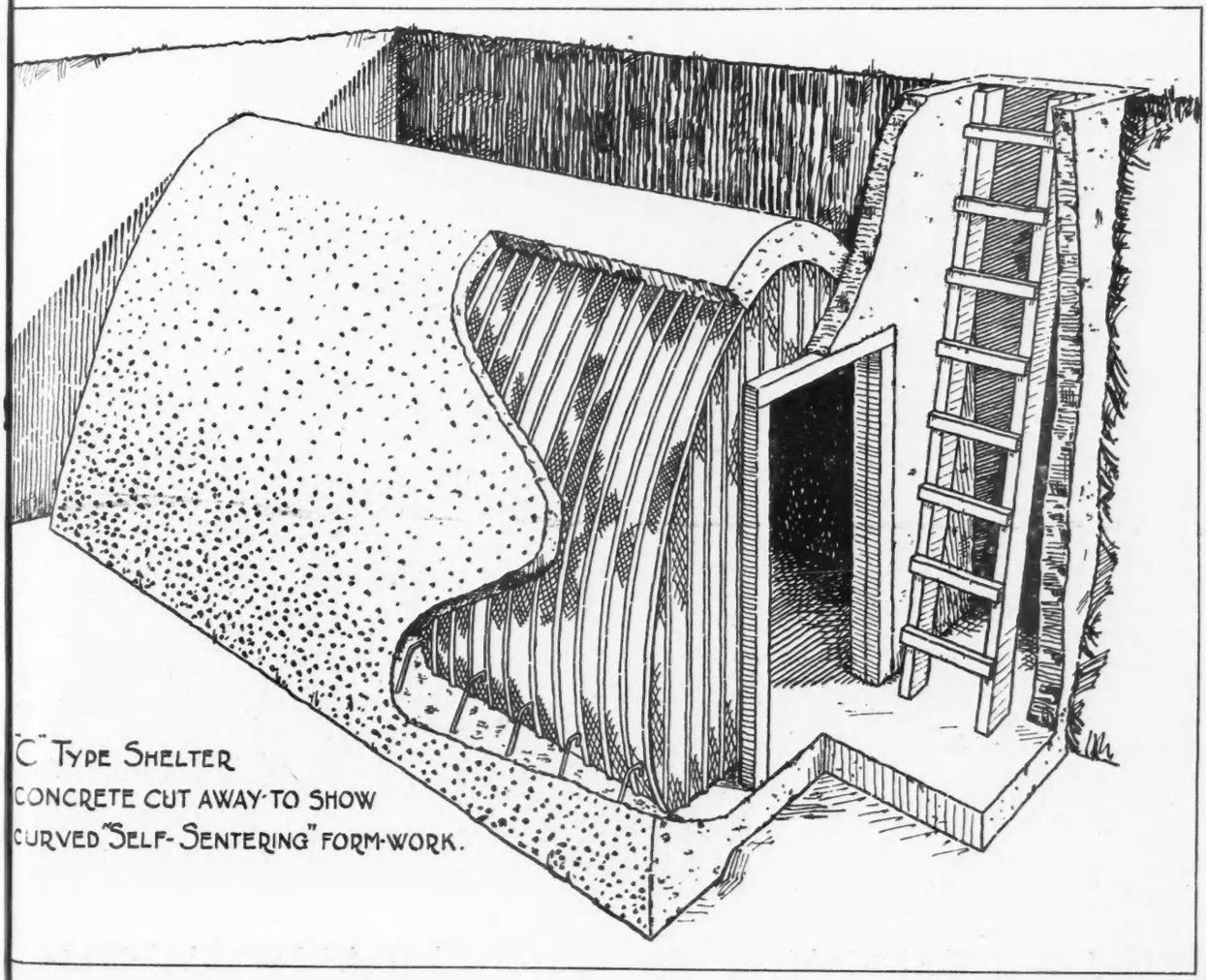

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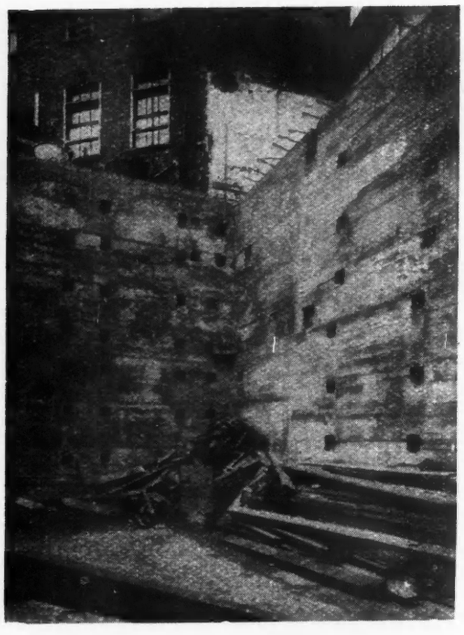

BOURNEMOUTH. Basement 30 ft. deep in water-bearing sand, to new WOOLWORTH Store. Reinforced concrete floor and retaining walls waterproofed with

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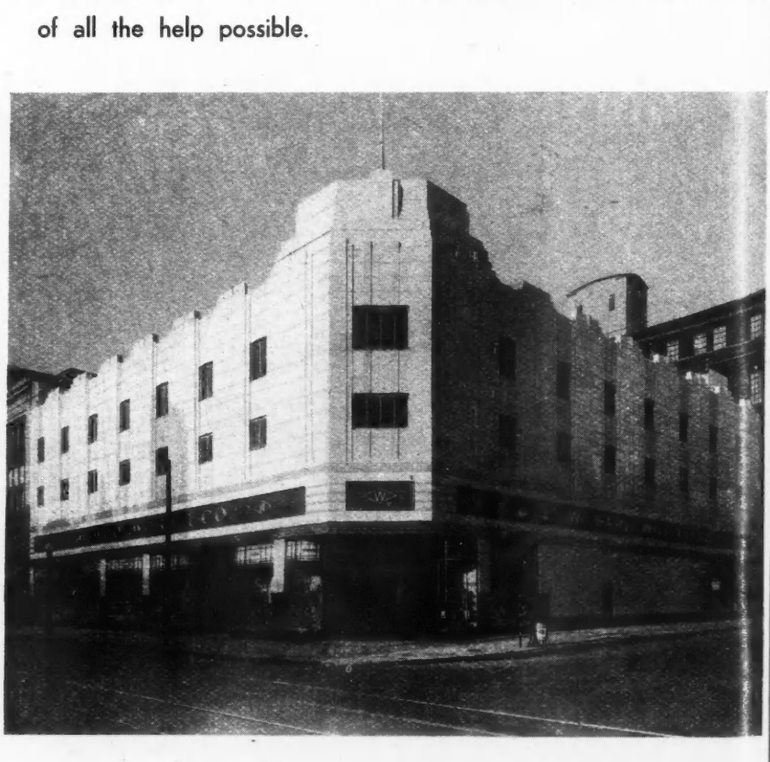
IF an air raid shelter is actually needed for protection, there will be no time to pump out flood water, and it would add greatly to the distress of those in it if pumping had to be continued, by hand, during occupation, when the air supply is restricted. The waterproofing of underground shelters does not differ materially from the waterproofing of deep basements, and for more than thirty years such problems have been successfully solved by the use of carefully graded concrete, adequately reinforced and made impervious by the addition of 'PUDLO' Brand cement waterproofer. Here are illustrated two examples of deep basements so waterproofed, both being surrounded by water-bearing sand. In all such structures, careful attention must be paid to the formation and disposition of construction joints, and in that—as in any other matter connected with the use of 'PUDLO' Brand waterproofer—we are glad to be of all the help possible.



MONTREAL, CANADA. This new WOOLWORTH Store also has its basement structure of reinforced concrete made impervious with 'PUDLO' Brand cement waterproofer. The subsoil was described as "a soft jelly-like mixture of clay and quicksand."

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Supplement to "The Builder," March 24 1939.

THE BUILDER
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STRUCTURAL PRECAUTIONS
against
AIR ATTACK—3.

An Approach to the Problem of Protective Shelters

The Need Both for a Temporary Scheme and a Long-Term Programme

An Investigation made by

Oscar A. Bayne, Felix J. Samuely and Conrad W. Hamann

LITTLE by little, as advice on how to stuff up cracks in the gas-proof room gives place to further advice on "How to construct a shelter in your home," and as this in turn fades into the background with the announcement that millions of steel shelters "proof against blast and splinters" are to be distributed, we progress, at each stage becoming more conscious that what seemed at first to be a poor sort of jest is in fact a most serious problem. A problem so serious and so all-inclusive in its threats that we cannot close our eyes to it as we have in the past to slums, bad housing, jerry-building and other social-architectural tragedies which do not directly impinge upon the limited field of architect-and-client within which the profession seems voluntarily to have limited itself.

This new problem is so colossal in its scope and its implications that it does in fact seem to be overpowering the architectural and engineering worlds. The flood of words in print continues and itself illustrates a poverty of outlook, a timidity and lack of grasp of fundamentals which would be staggering were it to come even from untrained laymen.

The architectural and engineering professions do not at present appear to be one iota ahead of the intelligent layman in their appreciation of the requirements, development or probable effect of A.R.P. in this country.

Existing Information.

Apart from the many aimless demands for "a plan" for "planned A.R.P." and for the work to be put in "technical hands," there has as yet been no effective contribution from any professional body or individual (if we except that valuable little survey by Serge Chermayeff called "Plan for A.R.P.").

There have, of course, been dozens, if not hundreds, of carefully worked out designs for garage-cum-shelters of all kinds, large and small, for shelters in all sorts of odd places in buildings and for tunnels and subways and underground roads and what not, "designed" without reference to the fundamental requirements of the problem; necessarily so, because the fundamental requirements have not yet been established. Design of this kind would, in other spheres, be called guessing. It cannot even be called estimating, which at least is based upon logic.

The requirements of a shelter in the open country cannot be the same as those for shelters in urban districts or for those in heavily populated areas. Shelters cannot be designed without reference to their location, use and relative effectiveness. Such factors are controlling factors, and unless they are taken into account a design can have no meaning at all.

Yet the urgent need for correlated information and a comprehensive survey of the factors which must be taken into account in the design of A.R.P. work do not seem to cause the professions any great discomfort.

This does appear to be a little surprising when it is realised that, broadly speaking, the existing published information readily available to architects and engineers consists of a report of a conference held at the R.I.B.A., a report by an independent group of young architects and technicians, based mainly upon experience in Spain (A.A.S.T.A. report), a book by C. W. Glover (Civil Defence), and a host of lesser works based upon them.

Beyond these few sources there are, of course, the Government handbooks, which in the main do not deal with the subjects most important to architects, and a great number of lesser reports, articles and letters published in the technical Press, most of which are mere opinions and few of which are authoritative or comprehensive even in the field with which they purport to deal. Much of the pseudo-technical trade literature cannot be regarded seriously and some of it not even as a jest.

At present it is from these many unrelated "scraps" that information is gleaned and pieced together with all its inadequacies and contradictions to make up the "data" from which architects and engineers must design if they are to design at all.

That we should be referring still to the published recommendations and requirements of foreign Governments for fundamental design data is bad enough, but when we remember that these figures are in the main recommendations and not statements of fact, that they are necessarily recommendations conditioned by all manner of local influences and political considerations, it is surely obvious that we are being forced into using a most unstable foundation as a basis for our work.

The Need for a Survey of Factors.

It is not untrue to say that at the present time two definite schools of thought appear to be developing: on the one hand, there is the "bombproof" school, and on the other, the "any-old-thing-does" school, and these two schools of "thought" are in fact being formed on an absence of thought. They are developing mainly on woolly political, humanitarian or pseudo-military grounds, without any sound groundwork of fact or logic.

It is tragic that this development should be going on as rapidly and as unjustifiably in the technical professions as it is in the lay world.

It must be possible to relate protective value to geographical, social and architectural conditions. Just how it can be done can only be determined during the course of, or as a result of, a survey made of all the factors likely to affect the design and location of shelters; but it is probable that the most important single factor involved is the density of population. (See "Partial Protection?" an article published in *The Builder*, A.R.P. Supplement No. 2, February 24, 1939.)

The density of population controls the density of shelters in any given area, and this in turn determines the likelihood of direct hits occurring. The figures given in the article referred to show that, in spite of the frequently repeated tag, "direct hits are so unlikely we can ignore them," the proportion of probable direct hits is so high in areas of medium and high density of population that they are the core of the whole problem. Far from being able to ignore them, we find that they represent the one phase which must be solved before all others.

The figures also show that degrees of protective value are, in fact, of great importance; that the solution is not to be found by deciding impetuously for or against either blast-resisting shelters or "bombproof" refuges. They show that each progressive increase in resistance to a direct hit specifically reduces the danger of an *effective* direct hit. For instance, blast-resisting shelters will be vulnerable to a direct hit from say a 50-lb. bomb, but if these shelters were replaced by shelters capable of resisting all bombs under 500 lb., then the chances of a direct hit would be reduced automatically to 1/10th, because an aeroplane, or any fleet of aeroplanes, could carry only 1/10th the number of 500 lb. bombs as they could 50-lb. bombs.

This and a great variety of other large-scale factors must be examined carefully and critically before any real headway can be made toward rational design of shelter accommodation.

Such an examination or survey should cover, amongst other factors:—

(i.) The effect, if any, of geographical situation.

(ii.) The effect, if any, of probability of attack (as distinct from the probability of direct hits if attacked).

(iii.) The effect of density of population on shelter design and location.

(iv.) The effect of building density and prevailing type of construction.

(v.) The effect, if any, of increasing size and reducing the number of shelters in any given district.

(vi.) The effect on the efficiency of shelters of increased protective value.

These and a number of other major related influences must be examined and conclusions drawn before any rational attempt can be made to determine the type of shelter and the amount of protection desirable for any given area. Only then can we begin to consider whether shelters should be above ground or below ground, in buildings or outside buildings.

It is very probable that it will be found that the structural strength required to give equal protective value will vary with the conditions of different districts and that, therefore, a classification of shelter types according to strength of construction will be required, and that these types must be related to the conditions (of density of population, geographical position, etc.) for which they are suitable.

But, having reached this point, we are then faced with the necessity of designing shelters to give the protection which has been determined for each group of the classification, and exact information will be required on a vast number of related details; information which is no doubt available but which is certainly not at present obtainable by the technical professions.

Some of the points which require to be elucidated include:—

Blast Effects.

1. The period required for blast effect to develop.
2. The exact distribution of and propagation of blast pressures and suctions, and the relation between distance and blast intensity.
3. The limits of variation (if any) to be expected from the formulæ for blast pressures now in use.
4. The direction of propagation of blast pressures and the extent to which they may be deflected.
5. The effect of the angle of incidence on the deflection of blast pressures.
6. The effect of surface friction on blast pressures.
7. The resistance of building materials and construction to blast pressures.

Concussion.

8. The effect of blast pressures and shock waves on human beings.
9. The relation (if any) between forms of pressure oscillation and other factors, and concussion effects.
10. The effects of protective screens and of enclosures in reducing or increasing the danger of concussion from blast and/or shock.

Fragments and Splinters.

11. The maximum distances from the different types of bombs at which splinters are dangerous to life.
12. The likelihood of a person being hit by a splinter from a certain bomb at various distances.
13. The relationship between splinter force and the distance from the source and the relationship to bomb-charge size.

Shock Wave.

14. The transmission of shock by various materials.
15. The effect of reinforcement, of its quantity and of its disposition, in concrete on the resistance of the whole to blast and shock.
16. The influence of the cube-strength of concrete on the resistance to blast and shock.

Resistance to Penetration.

17. The resistance of building materials to penetration.
18. The resistance of construction (as distinct from materials) to penetration; the effect of composite construction, laminated construction and reinforced construction on resistance to penetration.
19. The effect of quantity, type and disposition of reinforcement in concrete.
20. The effect of the direction of the span of a slab on its resistance to penetration.
21. The deflection (if any) of bombs and the effect of the angle of incidence on penetration.

Disruption.

22. The effect on different materials of explosion after penetration.
23. The effect on different forms of construction of explosion after penetration.
24. The effect of confinement on explosion.

The Need for Critical and Full Investigation.

While it is true that no thoroughly soundly based scheme of shelter accommodation can be evolved until the broad factors involved have been surveyed, and until adequate information is made available upon technical details such as those mentioned above, yet there are some phases of the present tendencies in A.R.P. work which could well be critically examined independently—such examinations may expose new aspects of importance or confirm existing beliefs.

One such aspect is the relationship between rapidly built light shelter accommodation and more heavily constructed near-bomb-proof construction which, on any large scale, would require a considerable period to complete.

Sir John Anderson has been quoted as follows: "Our first concern, therefore, must be to provide speedily a measure of protection for all who must stay in vulnerable areas. I can imagine nothing more dangerous to morale than to invite the public to place their faith only in a policy of protection which would of necessity be valueless to the vast majority if war came soon."

While most engineers and architects would prefer to examine the logic of the facts rather than to regard as gospel the words of any political figure however eminent, the emphasis given in this statement to the time factor cannot be ignored.

We are being prepared for war and it cannot be estimated how soon we are to be pushed into it. Assuming that there is some justification for the emphasis upon urgency, it is essential to take seriously into consideration the time factor, particularly in comparing the relative values of blast-resisting and near-bomb-proof construction. The following examination is an attempt to relate the two types of construction with particular reference to time, cost and efficiency.

The Time Factor in Relation to Shelter Efficiency.

For the purpose of illustrating the arguments of this investigation, the figures given in the scheme recently prepared by Messrs. Tecton for the Borough of Finsbury have been accepted, but with certain reservations. This scheme is the only example at present available in which a serious attempt has been made to survey the factors involved, and to relate them to the shelter design.

It must not be assumed, however, that the arguments advanced and the conclusions drawn apply only to Finsbury, for the problem is a general one and the method of approach put forward here can be and should be adopted in the scientific design of any protective scheme. It is shown later how this may be done, and a graph has been prepared to enable a decision on a protective programme to be made directly for any combination of (i) the proportion of shelter efficiencies, and (ii) the proportion of costs, *i.e.*, development times.

In the case of Finsbury a scientific approach to the problem has been made for the first time and lines of investigation developed, which give a sound basis for definite conclusions. That the conclusions drawn in the following notes diverge in some respects from those of the Finsbury scheme does not detract from the importance of the immensely valuable pioneering work carried out by the designers of that scheme.

Of particular interest is the introduction of the convention of the "danger volume," a mathematical solid, the shape and volume of which defines the relative danger from bomb explosions to which a person will be exposed.

The danger volume of an entirely unprotected person has been called 100 per cent., and the volume for those in trenches has been found to be between 10 per cent. and 70 per cent., depending on the construction of the trench. In a fully bombproof shelter the danger volume is, of course, zero. The danger volume convention may also be employed in another way: it can show the number of casualties likely among people sheltering under given conditions during an air raid. Thus in the Finsbury scheme it was estimated that the number of casualties caused by a ton of bombs in a district with a density of 180 people per acre among people who are unprotected would be 292, and only 28 per ton of bombs for people who are protected in efficient trenches. In Figure 1, curve "a" shows the danger volume for no protection at all. It is a solid with a base of 198 ft. diameter (which would be the range of blast for a $2\frac{1}{2}$-cwt. bomb), with a height of unity, representing the 100 per cent. probability of a bomb in the centre causing casualties there. The number of casualties per ton of bomb is calculated by multiplying this volume by eight, since there are eight bombs of $2\frac{1}{2}$ cwt. per ton. The danger volume for people in trenches is calculated similarly.

Fortunately for the community, the figures calculated in this way do not at all agree with the facts as reported from Spain, and particularly not in the cases of air raids which were unexpected, in which it may be assumed that many had not reached shelter accommodation at the time of the attack. It may be held that the number of people involved per ton of bombs is actually much smaller than the calculated figure, and that the number would not be higher than 50 amongst unprotected people in built-up areas.

Curve "b" in Figure 1 represents what might in fact be the actual danger volume in comparison with the theoretical volume (curve "a").

The reason for the incorrectness of the theoretically calculated figures may be found in what may be called a "natural protection." In a built-up area a certain protection against blast and splinters is afforded by the buildings themselves. There may be a possibility of replacing theoretical figures by values derived from practical experience as far as unprotected people are concerned, but the problem is much more difficult when it comes to the question of people in shelter accommodation.

There are at present no figures available for the average or probable number of casualties per ton of bombs amongst people occupying trenches or other shelters, and while it may be assumed that figures derived from practical experience would be lower than the calculated figures, it is not unreasonable to suppose that the divergence between the two sets of figures would be smaller than in the case of the unprotected.

For this reason the difference between the volumes represented by curves "c" and "d" in Figure 1 is less than that between the volumes represented by curves "a" and "b."

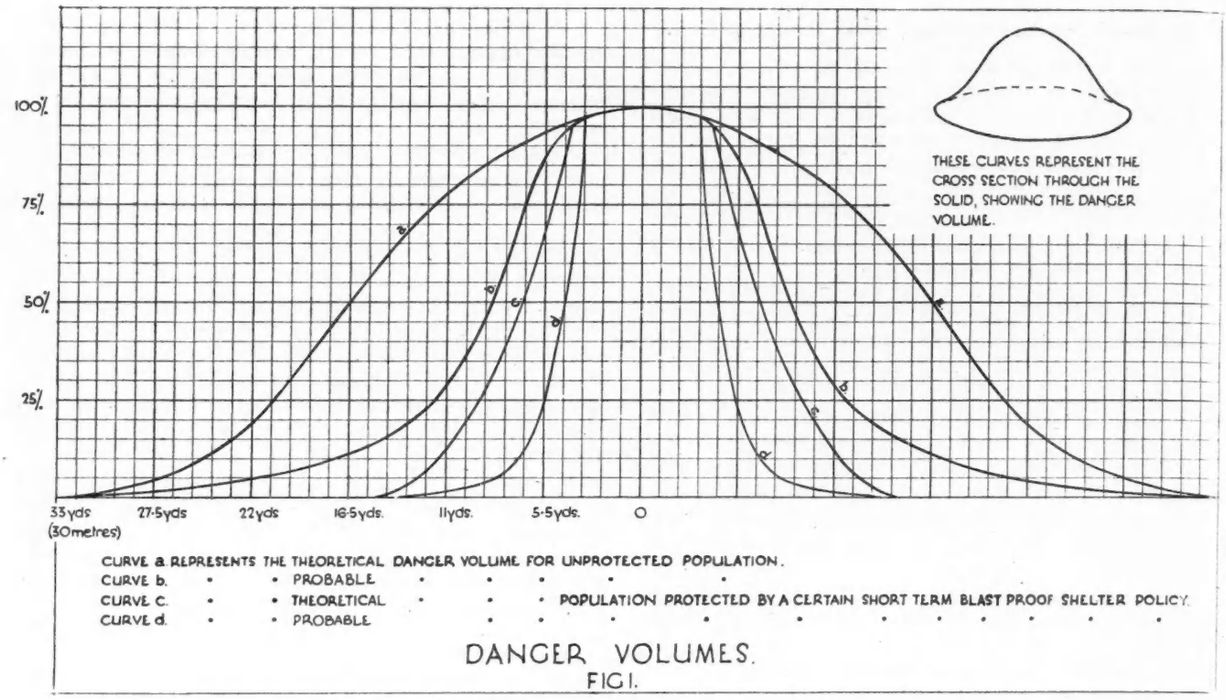
The Time Factor.

Having established an approximate method of relating the relative values of shelter accommodation, an examination must be made of the effect of the time factor in construction on the efficiency of the shelters.

Obviously a shelter scheme will have a certain predetermined efficiency *when complete*, but the period of construction is very important and it may be, for instance, that an almost complete scheme of "bombproof" protection is less efficient at that stage than a complete scheme giving blast-resisting protection.

In the following analysis the word "cost" has been used to represent development. It includes man power, materials and time and where, for example, it is pointed out that "costs" govern the primary selection of a protective scheme, it is not intended to suggest that from a monetary point of view the particular scheme cannot be afforded.

This fact *must* be appreciated, for the argument appears to favour "blast and splinter" protective schemes which, in spite of possible prejudices, have


100%
75%
50%
25%
33 yds (30 metres)
27·5 yds
22 yds
16·5 yds.
11 yds.
5·5 yds.
0
THESE CURVES REPRESENT THE CROSS SECTION THROUGH THE SOLID, SHOWING THE DANGER VOLUME.
CURVE a REPRESENTS THE THEORETICAL DANGER VOLUME FOR UNPROTECTED POPULATION.
CURVE b. • • PROBABLE
CURVE C. • • THEORETICAL
CURVE d. • • PROBABLE
POPULATION PROTECTED BY A CERTAIN SHORT TERM BLAST PROOF SHELTER POLICY.

DANGER VOLUMES.
FIG 1.

certain very definite uses and advantages. It must also be realised that they are only a means to an end, and that the end is a shelter system which affords the greatest degree of protection not only when complete but at any stage of development.

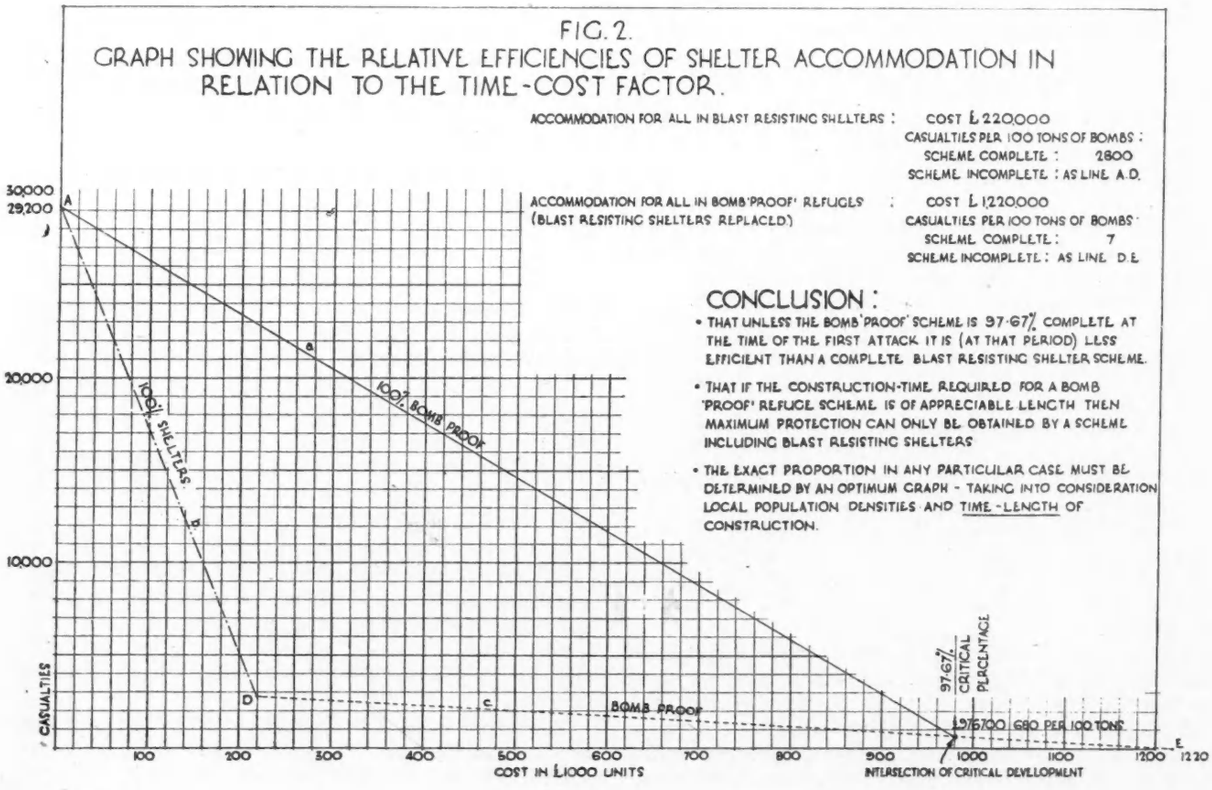
Figure 2, which is based on the figures given in the Finsbury report, shows the relationships between the development of an air raid shelter scheme and the likely casualties under an air raid at any stage of that development.

If protection consisting only of bombproof shelters is provided, the casualties per 100 tons of bombs falls steadily (from the start to the completion of the shelters for 100 per cent. of the population) from 29,200 practically to 0.

The effect of the construction of a bombproof scheme is represented by the line " a " in Fig. 2, and the effect of the construction of a scheme of blast-resisting shelters is represented by the line " b." If the cost of construction is taken as a rough guide to the length of time required to build the shelters, then it will be seen that blast-resisting shelter accommodation provides in a relatively short time a relatively high degree of protection. For instance, the blast-resisting shelters, when complete (point D,) reduce the casualty rate to 2,800 for an expenditure of £220,000. At the corresponding stage of expenditure in the bombproof shelter scheme the casualty rate remains as high as 22,800 persons per 100 tons of bombs.

It is obvious that the bombproof scheme alone will

FIG. 2.
GRAPH SHOWING THE RELATIVE EFFICIENCIES OF SHELTER ACCOMMODATION IN RELATION TO THE TIME-COST FACTOR.


ACCOMMODATION FOR ALL IN BLAST RESISTING SHELTERS : COST £220,000
CASUALTIES PER 100 TONS OF BOMBS : SCHEME COMPLETE : 2800
SCHEME INCOMPLETE : AS LINE A.D.
ACCOMMODATION FOR ALL IN BOMB 'PROOF' REFUGES (BLAST RESISTING SHELTERS REPLACED) : COST £1,220,000
CASUALTIES PER 100 TONS OF BOMBS : SCHEME COMPLETE : 7
SCHEME INCOMPLETE : AS LINE D.E
CONCLUSION :
• THAT UNLESS THE BOMB 'PROOF' SCHEME IS 97·67% COMPLETE AT THE TIME OF THE FIRST ATTACK IT IS (AT THAT PERIOD) LESS EFFICIENT THAN A COMPLETE BLAST RESISTING SHELTER SCHEME.
• THAT IF THE CONSTRUCTION-TIME REQUIRED FOR A BOMB 'PROOF' REFUGE SCHEME IS OF APPRECIABLE LENGTH THEN MAXIMUM PROTECTION CAN ONLY BE OBTAINED BY A SCHEME INCLUDING BLAST RESISTING SHELTERS
• THE EXACT PROPORTION IN ANY PARTICULAR CASE MUST BE DETERMINED BY AN OPTIMUM GRAPH - TAKING INTO CONSIDERATION LOCAL POPULATION DENSITIES AND TIME-LENGTH OF CONSTRUCTION.
30,000
29,200
20,000
10,000
CASUALTIES
A
a
100% BOMB PROOF
100% SHELTERS
b
D
c
BOMB PROOF
97·67% CRITICAL PERCENTAGE
1,976,700 680 PER 100 TONS
E
100
200
300
400
500
600
700
800
900
1000
1100
1200
1220
COST IN £1000 UNITS
INTERSECTION OF CRITICAL DEVELOPMENT

not be as effective as the blast-resisting scheme until it is sufficiently far advanced to reduce the casualty rate to that of the completed blast-resisting scheme, namely to 2,800. From the graph it will be seen that this stage is not reached until the expenditure has reached £900,000—that is, not until the scheme is 90 per cent. complete.

If the period of peace remaining to us is likely to be short (see Sir John Anderson's remarks above) and the period of construction required for a large scale bombproof shelter building programme is long, then such a programme is likely to be thoroughly inadequate.

Yet a blast-resisting shelter scheme in itself is also quite inadequate.

Even the already high percentage of 90 mentioned above is not, however, the value which finally determines the relative efficiencies of the two systems, for it is clear if the whole of the short-term scheme is completed first and then "bombproof" shelters are developed to the further extent of £680,000, the same total of £900,000 will have been developed, but the casualties will have been reduced from 2,800 to 896 (line "c" Figure 2). It is not until a percentage of 97.67 is reached that the efficiency of this combined programme is equalled by that of the "bombproof" scheme alone. This latter value (97.67 per cent.) is the decisive value for the particular case of the Finsbury figures. Further consideration will be given to this very important "critical percentage" later.

It appears, then, that a double programme is required to meet the facts of the situation: a scheme of temporary blast-resisting shelter accommodation capable of being rapidly brought to completion, coupled with a long-term programme giving a measure of protection which is based upon the degree of vulnerability and not upon rapidity of construction.

This may appear to be merely extravagance piled upon extravagance, yet it will be seen that accepting the figures given in the Finsbury scheme as a basis for the time being, the cost of a complete temporary programme, followed by a complete long-term scheme, is only 22 per cent. greater than the cost of the long-term scheme alone. It remains, then, to consider whether the two time-factors mentioned above demand such a double programme.

The first, the length of peace-time remaining to us, is not capable of being estimated except by a few persons, who, to say the least, are not likely to make any reliable public announcement on the subject.

The second, the length of time required to construct bombproof or near-bombproof shelters on a gigantic scale, is extremely difficult to estimate, but limitations imposed by the supply of man-power, materials and equipment would appear to make it a matter of years and not of months, although it is perfectly true that any individual scheme (such as Finsbury) might be constructed in a short time with adequate organisation and the will to do so.

Consideration of the time-factor cannot here be taken further than that, but in the absence of an adequate survey of available labour and the supply of materials, it is not unjustifiable to assume that the speed of construction of the long-term programme could not be sufficiently fast to meet the demand for urgency implied in Sir John Anderson's statement.

It remains, then, to consider the effect of combining a short-term (blast-resisting) shelter programme with a long-term programme of bombproof or near-bombproof construction. The lines A D and D E represent these programmes operating together, the total cost being £1,220,000, the casualty rate being reduced to 2,800 per 100 tons of bombs after the expenditure of the first £220,000, and practically to zero at £1,220,000.

A Compromise Programme.

Fig. 3 represents the effects of developing a compromise programme consisting of simultaneous construction of some blast-resisting shelters together with near-bombproof shelters. In the particular example it has been assumed that blast-resisting shelters would be available for 50 per cent. of the population, and "bombproof" shelters for 50 per cent. The cost would be £610,000 and, when ready, would reduce the casualties to 1,400 per 100 tons of bombs. Again, the better programme would be to complete the short-term protection first and then to proceed with the "bombproof" shelters; that is to say, the lines "b" and "a_2" should be followed in preference to lines "a" and "b_2," because at any stage of development the casualties due to an attack would be fewer. For instance, at a development represented by £450,000, they would be about 16,100 per 100 tons if the "bombproof" shelters were given priority, as against 6,000 per 100 tons if the short-term scheme were constructed first.

After this composite programme had been completed and protection of one type or the other provided for all the population, it should be continued by the extension of "bombproof" shelters to absorb those depending still on the short-term protection. This would mean a further development of £500,000, bringing the total cost to £1,110,000, but reducing the casualties from 1,400 per 100 tons to zero (line "c," Fig. 3). In this case it is found that the intersection of the lines "a" and "c" is not reached until the point representing 99.07 per cent. of the "bombproof" scheme alone is met. Thus the critical percentage of the compromise scheme is 99.07. This means, unless 99.07 per cent. of a "bombproof" scheme would be available before the first attack, that, of the two, the compromise scheme with its greater protection at any earlier stage is infinitely to be preferred. It must be appreciated that that is true only as far as the compromise and the "bombproof" schemes are concerned. It should not be inferred that the compromise scheme is necessarily better than that represented by lines "b" and "C" in Fig. 2, because, although its ultimate cost is less, it is better only if the £610,000 development (point "C," Fig. 3) is completed before the first raid. If this stage has not been reached, the casualties will be much greater than in the complete short-term and then "bombproof" programme, represented in Fig. 2. For example, at a development of £250,000, a raid would involve 12,000 casualties per ton under the composite scheme (Fig. 3), but only 2,700 per ton if full instead of 50 per cent. short-term protection had been available.

It is clear that economies are to be obtained by reducing the number of blast-resisting shelters, but also that such economies delay the reduction of the casualty rate.

The Figures.

While the figures used above to express cost, casualties and other factors are believed to give a basically sound *relative* representation of the facts, there are, owing to the absence of adequate data, many possible qualifications which should be borne in mind.

The more important points are:—

(*a*) Owing to the lack of reliable figures the proportion between casualties amongst unprotected people and amongst people in trenches may be considerably modified.

(*b*) Other types of trenches than those assumed for Finsbury may also alter this proportion.

(*c*) The relative costs and the development programmes for the short- and long-term systems may vary considerably, and there are many who doubt that near-bomb-proof shelters can be constructed for the prices given in the Finsbury report.

(*d*) The costs of different types of near-bomb-proof shelters vary considerably, and the costs per person increase as the number of people decreases.

The Importance of the Critical Percentage.

In connection with Figs. 2 and 3, reference has been made to the intersection of the two lines representing

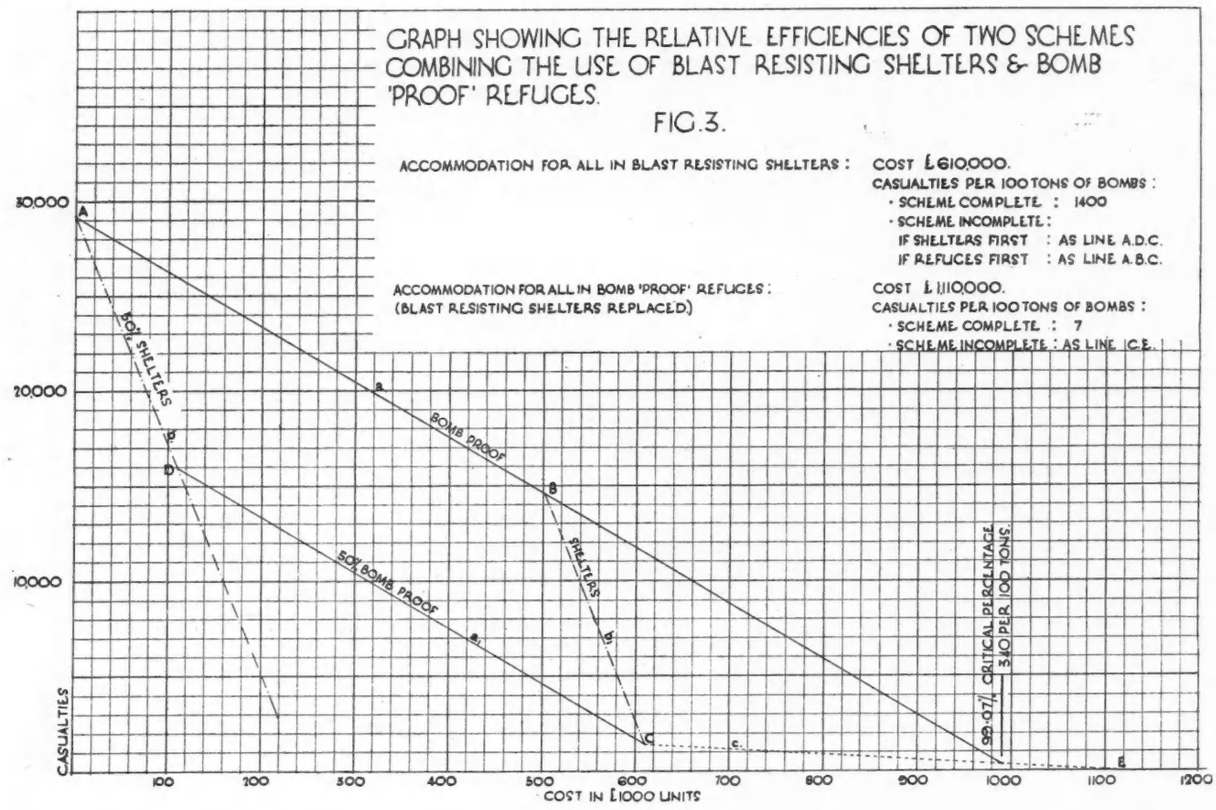
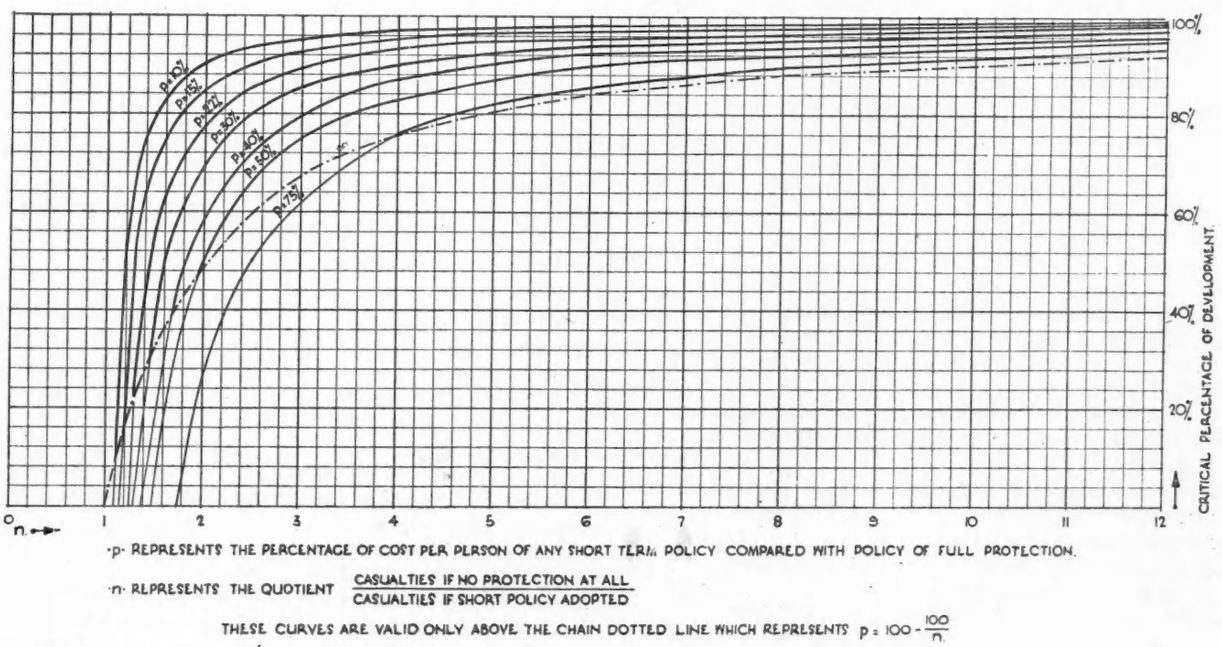


FIG. 3.

the developments of the short- and long-term programmes, and this inter-section has been called the "critical percentage" of casualties. In Fig. 4 curves have been given setting out the critical percentages for different proportions of costs and of protection. This diagram is to be read as follows :—

If the casualties which would occur without any protection whatever are shown (by the danger volumes) to be "n" times the casualties under a short-term protective scheme, and, further, if the cost of the short-term system is "p" per cent. of that of the bomb-proof shelters (in each case considering the cost for the whole population), then the curve set out for that particular percentage "p" must be followed until the ordinate for the given "n" ratio is met. The length of this ordinate from the base to the point of intersection represents the critical percentage, and the value can be read off on the scale at the side. In all cases in which the critical percentage is higher than 90, it is definitely preferable to start first the development of the cheaper and less efficient type of shelter.

These figures show, for example, that if a short-term policy costs only 10 per cent. of the other, the critical percentage is as high as 90 per cent. when the factor of safety is no higher than two. In other words, even when the number of casualties is reduced only to one-half, it is still of considerable value to start with the short-term shelters. If now the short-term shelters cost



CURVE SHOWING THE DEPENDENCY OF THE CRITICAL PERCENTAGE OF CASUALTIES.

FIG. 4.

40 per cent. of the fully bombproof shelters, when the 90 per cent. limit is reached, the number of casualties is reduced only to one-fifth. Thus, if the reduction of casualties is less, it is not actually worth while to start a short-term policy.

By this method one does not, of course, have to work out and examine the actual casualties in terms of the relative costs of the alternative systems. It is the purpose in putting forward the idea of the "critical percentage" and also the curves in Fig. 4, which simplify its determination, that one could come immediately to a decision on any scheme. It has been suggested that the criterion should be a critical percentage of 90, and that for conditions giving values below that figure short-term policies were not worth while, whereas they should definitely be carried out first under conditions giving values above 90 per cent.

Again, whether this criterion (90 per cent.) is to be generally adopted or not does not affect the principles nor even the details of the investigation in any way. For example, under certain conditions (density of population, etc.) it might be considered that a short-term scheme had to be carried out as a preliminary even if its cost was 35 per cent. of the cost of a "bombproof" scheme and the casualties were reduced only to one-third. Such a system has a critical percentage of 86 (see Fig. 4). It is considered, however, that 90 is a sufficiently low value, for there is always the danger, in spite of all good intentions originally, that such a scheme having cost a relatively high sum would not readily be replaced even in view of its not being a very efficient system.

Just as there is a very grave risk of rigorous adherence to the "only 'bombproof' shelters" policy, leading the community into the danger of being caught with insufficient shelter accommodation, so, too, there is a serious risk that once a short-term protection has been provided, it will become regarded as an adequate A.R.P. measure.

Of the two evils, the latter seems to be the less, for its remedy remains always within grasp.

Conclusion.

While these notes are not intended to form an argument for or against the use of bombproof or blast-resisting shelters, they do, to some extent, throw light upon their relative values during a particular period, and, further, they outline a process of reasoning by which those relative values can be assessed, so that into a somewhat chaotic state of thought on A.R.P. a little order may be introduced. It would be a poor system of protection which, because it was incomplete, proved to be less efficient than the Government type of steel shell.

Although it is a small matter in comparison with other difficulties of determining the right type of shelter accommodation for any given district or set of conditions, yet the question of the time-lag is a very important one if the time remaining to us is short. It is to be hoped that the difficulty of providing adequate protection during this period will not be regarded as yet another argument against building near-bomb-proof construction where it is required.

A Report on Structural A.R.P.

Recommendations by the Institution of Structural Engineers

The Air Raid Precautions Committee of the Institution of Structural Engineers, 11, Upper Belgrave-street, London, S.W.1, has now issued its complete Report on Air Raid Precautions which contains two additional parts namely, Part III—"Air Raid Shelters," and Part IV—"New buildings," to the Report issued in October last year. (Reference to Parts I and II—"A Digest of Published Information" and "The Committee's Recommendations for Protecting Existing Buildings" respectively—was made in *The Builder*, November 4, 1938).

In Parts III and IV certain matters have been dealt with more comprehensively, and it has been found necessary to revise Parts I and II in the light of subsequent information which has now been received.

Copies of the complete Report are obtainable from the offices of the Institution, price 2s., including postage.

Parts III and IV deal with air raid shelters and provisions recommended for incorporation in new buildings. In Part III the Report deals exclusively with the structural requirements for the design of air raid shelters.

In the Report the Institution has considered shelters as being classified under two main headings, namely, shelters giving complete protection against direct hits and those designed to be proof against blast and splinters only. For shelters proof against direct hits, tables are given of the required thicknesses for roofs or slabs over shelters and the estimated force exerted by bombs on impact. With regard to the shape of small shelters attention is directed to the additional strength in the case of a shelter built in the form of a cone or a sphere as against a rectangular form.

In the case of large communal shelters, these may be protected by detonating slabs of a thickness not less than that recommended in the tables. Attention is drawn to the importance of protecting against concussion as the result of a bomb striking a solidly constructed shelter which, although capable of keeping out the bomb, might cause death to the occupants from concussion. A strong recommendation is made that shelters should be built of a composite construction consisting of (1) A detonating slab at the top; (2) A cushion; (3) An internal shelter casing.

The Detonating Slab.

The thickness of the outer detonating slab should not be less than that given in the tables and should be strong enough to prevent complete penetration. The cushion layer should be at least the same thickness as the detonating slab and should be composed of material containing voids which can be compressed (such as loose sand) and which would be capable of considerable movement with increase of pressure. The inner casing must be sufficiently strong to carry its own weight and the weight of the superimposed layer in addition to the considerable increase in pressure to which the cushion layer is subjected on impact from a bomb. Recommendations are given for the construction of shelters above ground and below ground which would be proof against direct hits.

The latter portion of Part III is devoted to shelters constructed above or below ground which would be proof against splinters only. Attention is drawn to the importance of considering shelters having at least two entrances of adequate size, and also the spacing of shelters which should be related to the warning period and be not greater than will permit every prospective occupant to reach the entrance well within this period. Assuming the period to be taken as two minutes, it is recommended that the maximum distance of every prospective occupant from his shelter should be somewhere about 200 yards.

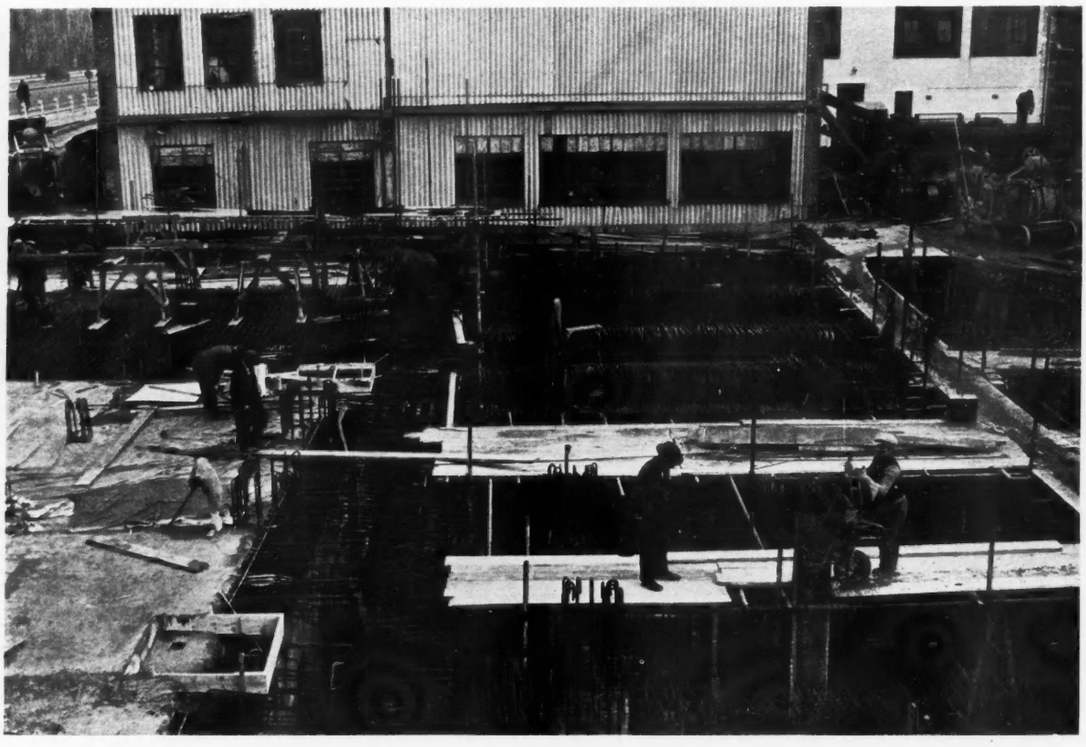
In dealing with provisions for new buildings, two aspects have been considered, namely, those designed to resist direct hits and those not so designed, but capable of affording resistance to blast, splinters and general collapse due to bombs exploding outside. In the case of buildings which fall within the first class, it is recommended that the roofs should be of a thickness not less than the figures given in the tables, and that the stanchions supporting the roofs should be designed to carry a point load at any point equal to the figure specified in the tables, in addition to its dead load. The elimination of windows is recommended.

Concussion.

To guard against concussion the composite construction previously referred to for shelters is recommended, and may be obtained by constructing the roof of a thickness sufficient to resist the penetration of bombs, thus causing them to explode outside, the top floor to serve as the cushion layer, and consequently left unoccupied. The shelter proper would consist of the lower floors, where the occupants would take refuge. With regard to new buildings not designed to be resistant to direct hits, preference is given to framed structures consisting of a skeleton framework of steel or reinforced concrete members which carry the roof, floors and walls; this skeleton of light steel members dividing the roof, floors and walls into comparatively small and light sections which, in the case of an explosion, would be blown away from the framework inwards or outwards without jeopardising the main structure as a whole or any large portion of it.

Experience has shown that damage from explosion to framed structures is usually local and comparatively slight and repairs can be effected cheaply and rapidly by the replacement of wall panels, repairs to damaged walls and roof and the strengthening of weakened main members; this enables the building to be kept in use. In the case of weight-bearing buildings, these are liable to extensive damage, causing masses of heavy material to fall, thus causing difficulties for the rescue gangs and blockages to adjacent streets.

In new buildings it is strongly recommended that all projections, such as chimney breasts, canopies, balconies, cornices, etc., should be integrally tied to the main structure in a manner far more secure than has been adopted in buildings hitherto erected.

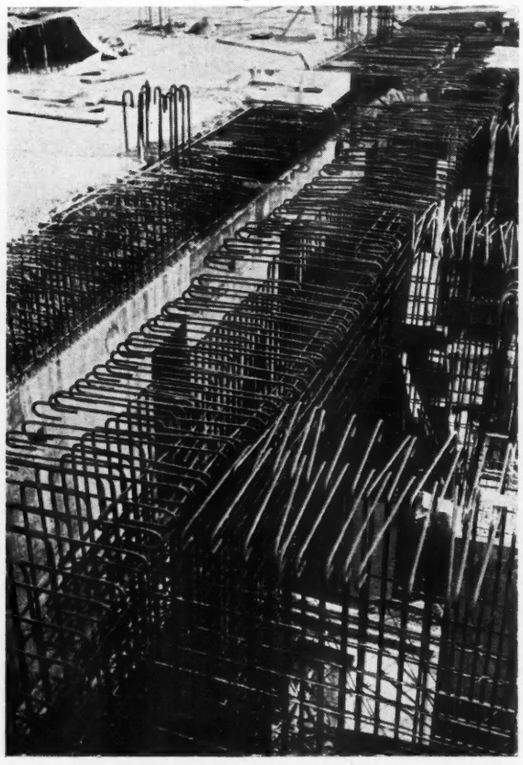


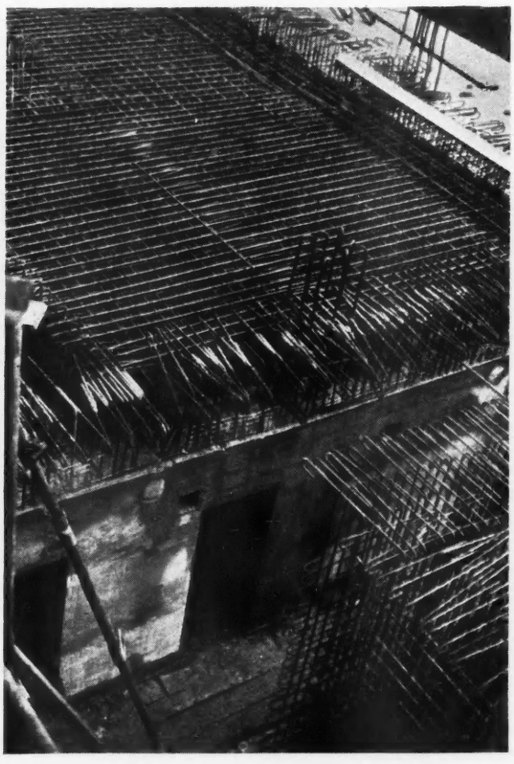
GENERAL VIEW OF SHELTER UNDER CONSTRUCTION.

A FACTORY STRONGHOLD SHELTER, BRENTFORD, MIDDLESEX.

This shelter has been erected for the use of the employees of Messrs. Simmonds Aerocessories, Ltd., at their Brentford factory. The ground upon which the stronghold rests is waterlogged, and it was, therefore, necessary to drive steel sheet piles to a depth of 25 ft. below ground level to enclose the area. After the piling was completed the earth was completely excavated down to a depth of 21 ft., where blue clay was exposed. The maximum bearing pressure of the foundations on the blue clay was calculated at 4 tons to the foot super.

The total load of the superstructure above main floor level is 10,000 tons, and this load is carried by reinforced concrete columns through the stronghold to individual foundations below floor level.





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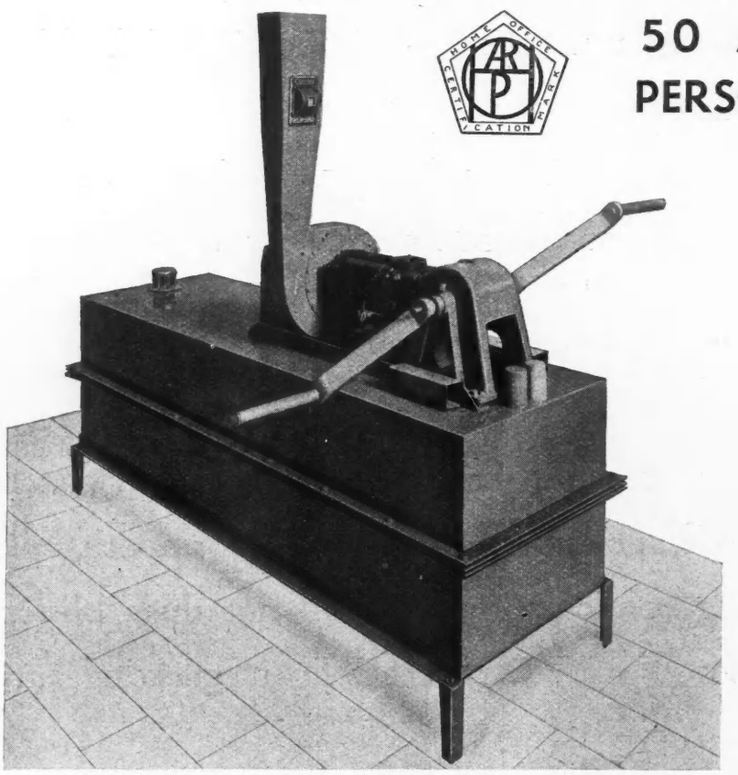

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The floor slab of the stronghold is 1 ft. 6 in. thick, the roof over the stronghold 2 ft. 6 in. thick, and the main floor slab above the stronghold 8 in. thick, all in reinforced concrete. The external walls are 2 ft. 9 in. thick, and the internal walls 1 ft. 6 in. thick, also in reinforced concrete. All external faces of all walls have 1½-in. square mesh fabric to prevent large spalling.

The concrete is composed of four parts of ballast and two parts of sand (both carefully graded) to one part of cement, and is vibrated in the shuttering, resulting in a crushing strength after 28 days of 5,000 lb. to the square inch.

The main floor slab is designed to carry a load of 6 cwt. per sq. ft. in addition to its own weight, with a 20-ton punching load. This is sufficient to take the falling debris from the building over. The stronghold roof, with the aid of the main floor and the floors over, will be able to resist a direct hit from a 500-lb. bomb throughout, and in the centre part, where there are more floors, possibly from a 1,000-lb. bomb. There are one main and two secondary entrance stairways, and four emergency exits.

To give an idea of the extent of the structure, 125 tons of steel sheet piling were used, and over 4,000 cubic yards of concrete are contained in the structure, together with 350 tons of mild steel bars, both plain and of "Isteg" form.

There are also 47 gas-proof steel doors fixed in the structure.

The ventilating and filtering plant is on the plenum system, all to Home Office specification. Independent and duplicated electric generating sets are employed, together with diesel engines for light, heating and cooling; they also supply power for water pumps, ventilators, telephones, etc. Separate drainage is provided for contaminated and uncontaminated water to separate sumps.

Fresh water is contained in a storage tank and is conveyed to the various points *via* pressure tanks.

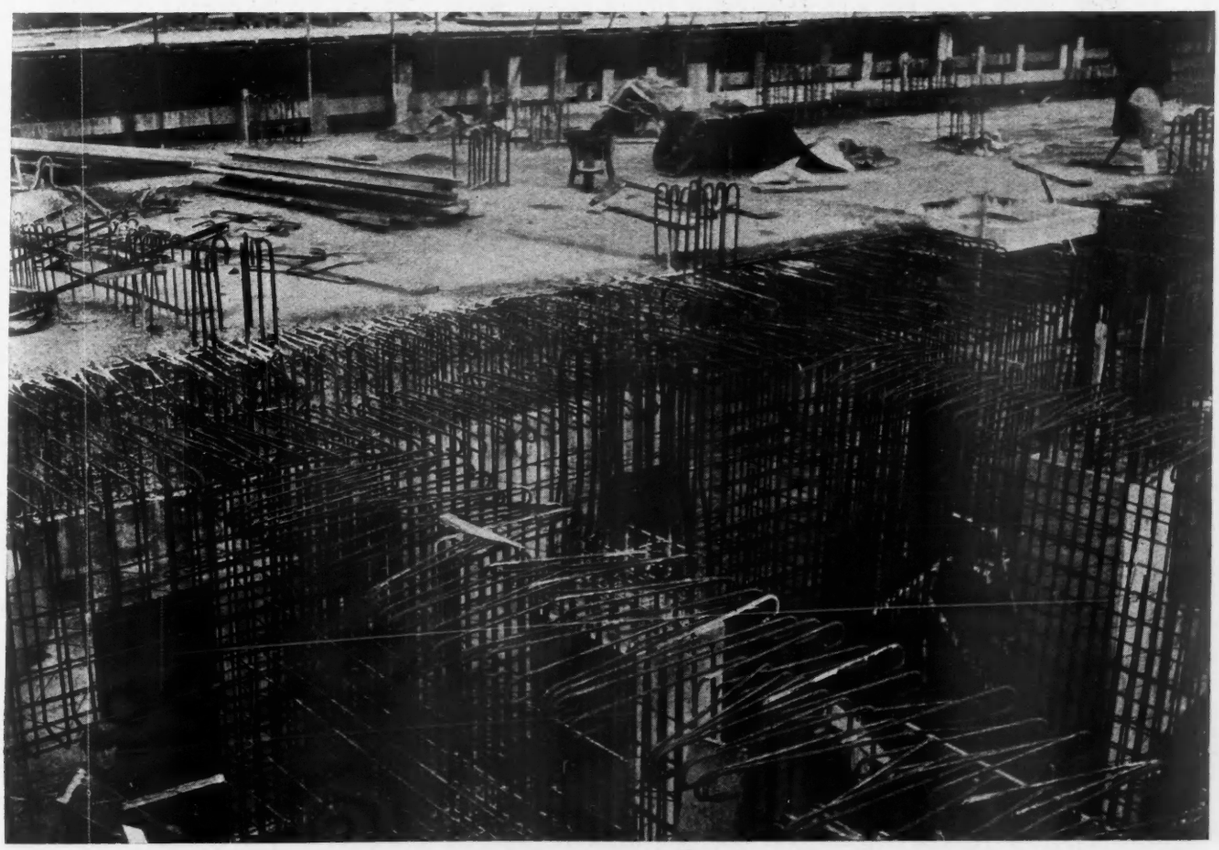
The control room is centrally placed and houses the telephone exchange to inside the stronghold, as well as to points outside, and also to observation points. It also contains the wireless set and transmitter to loud-speakers in the various compartments, together with gauges for indicating temperatures, humidity, air-flow, etc., in the stronghold.

There are 13 compartments, accommodating 714 persons, while control, hospital, surgery, air locks, plant room and decontamination hold a further 46 persons—a total of 760 persons. For the purpose of the above totals the main corridor has been assumed unoccupied. Reference should be made to the plan and section given on page xviii.

The general contractors for the work are Messrs. John Laing & Sons, Ltd. The ventilating plant is supplied by the Carrier Engineering Co., Ltd., and the diesel engine sets by Messrs. Davey, Paxman & Co. (Colchester), Ltd. The steel doors are by the Chatwood Safe Co.

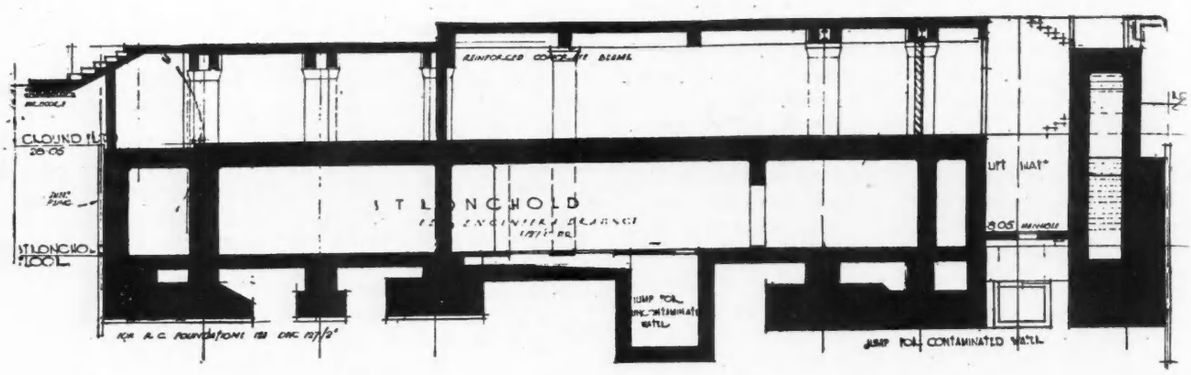
The general specification and layout of the stronghold was drawn up by Mr. Oliver Simmonds, M.P., managing director of Simmonds Aerocessories, Ltd., and the President of the Air Raid Protection Institute, following a careful study of air-raid shelters in France, Germany and Spain.

The consulting engineer under A.R.P. and for the reinforcement to the stronghold is Mr. C. F. de Steiger, and the architects are Messrs. Wallis. Gilbert & Partners.

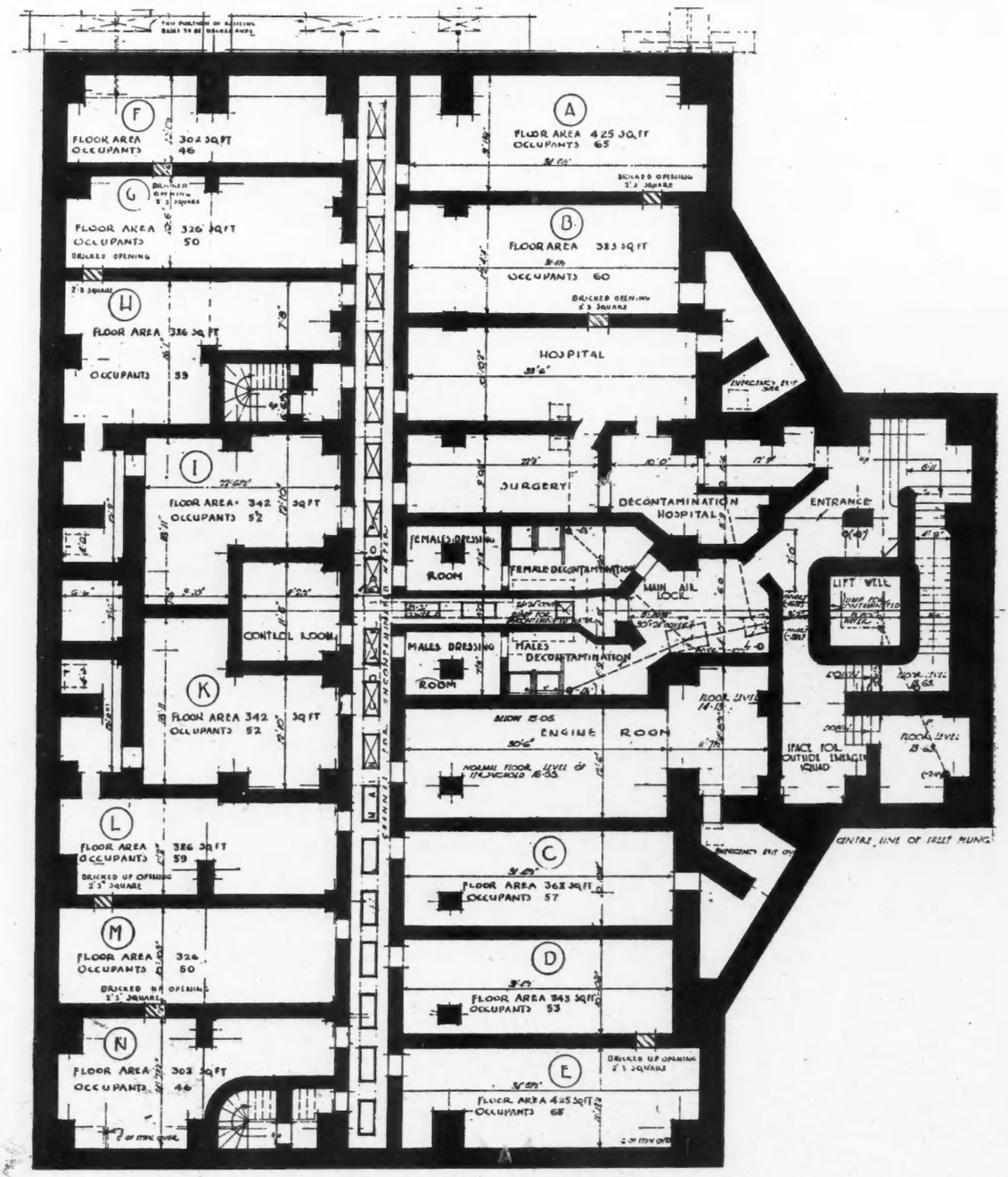


ANOTHER VIEW OF REINFORCEMENT, SHOWING WALLS UNDER CONSTRUCTION.

A FACTORY STRONGHOLD SHELTER, BRENTFORD, MIDDLESEX.



CROSS SECTION B·D



CROSS-SECTION AND PLAN OF SHELTER.

A FACTORY STRONGHOLD SHELTER, BRENTFORD, MIDDLESEX.

GENERAL DESIGN BY MR. OLIVER SIMMONDS, M.P. MR. C. F. DE STEIGER, CONSULTING ENGINEER.
MESSRS. WALLIS, GILBERT AND PARTNERS, FF.R.I.B.A., ARCHITECTS.

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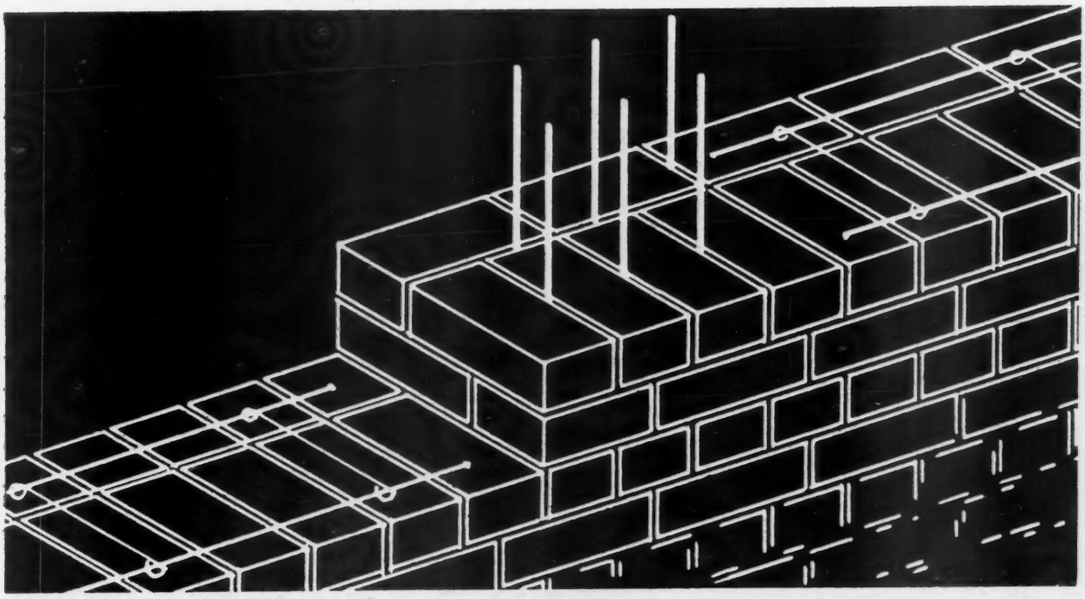

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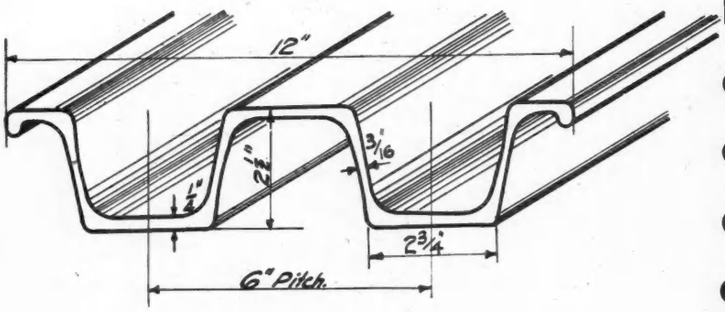
(Illustrated on left)



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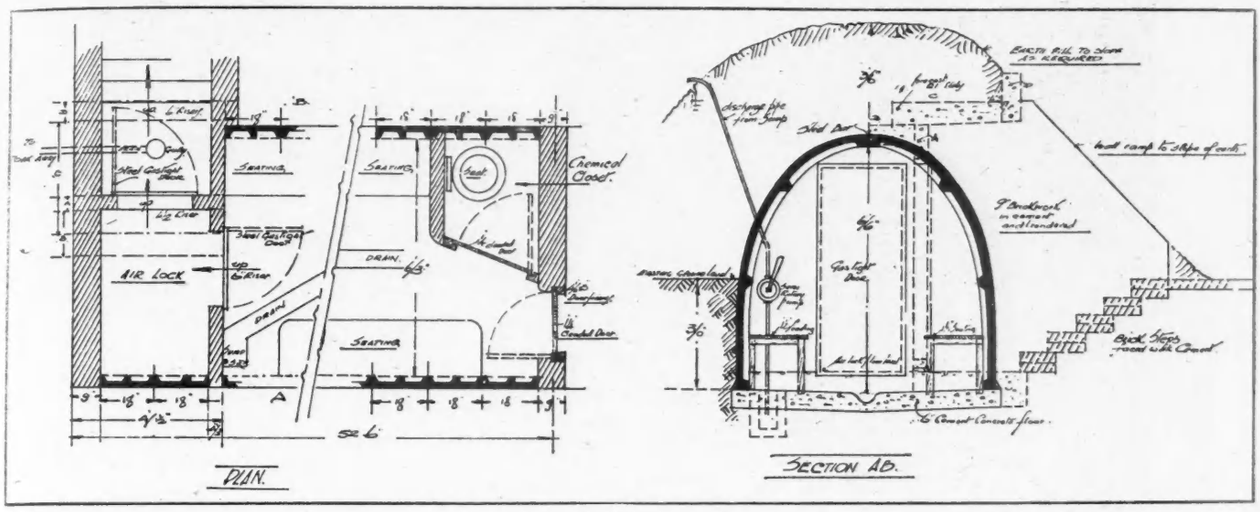
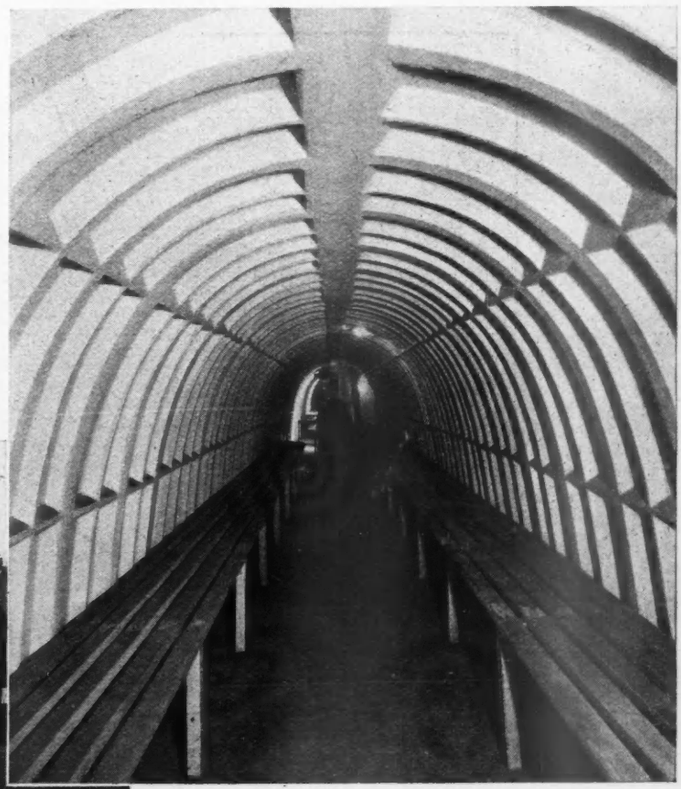
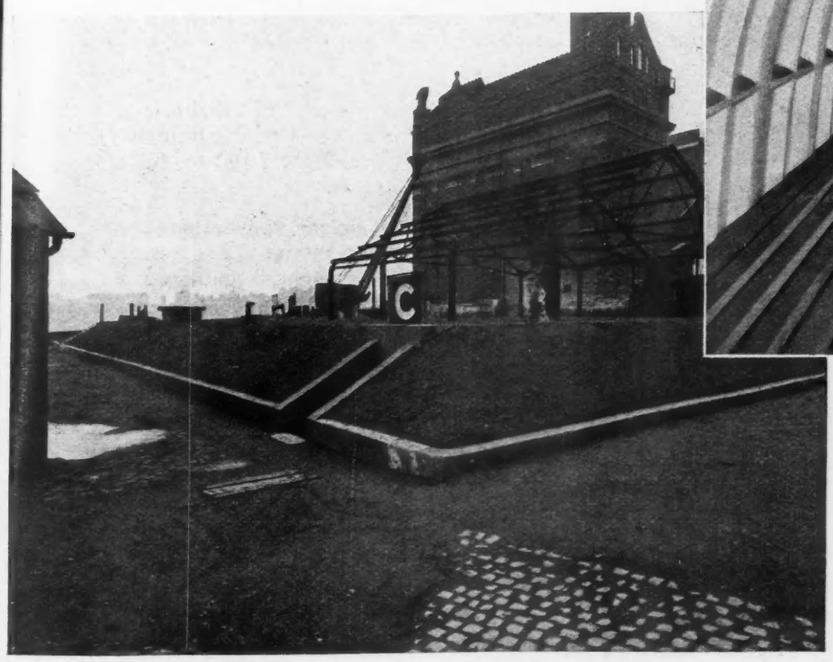


PLAN AND SECTION A—B.

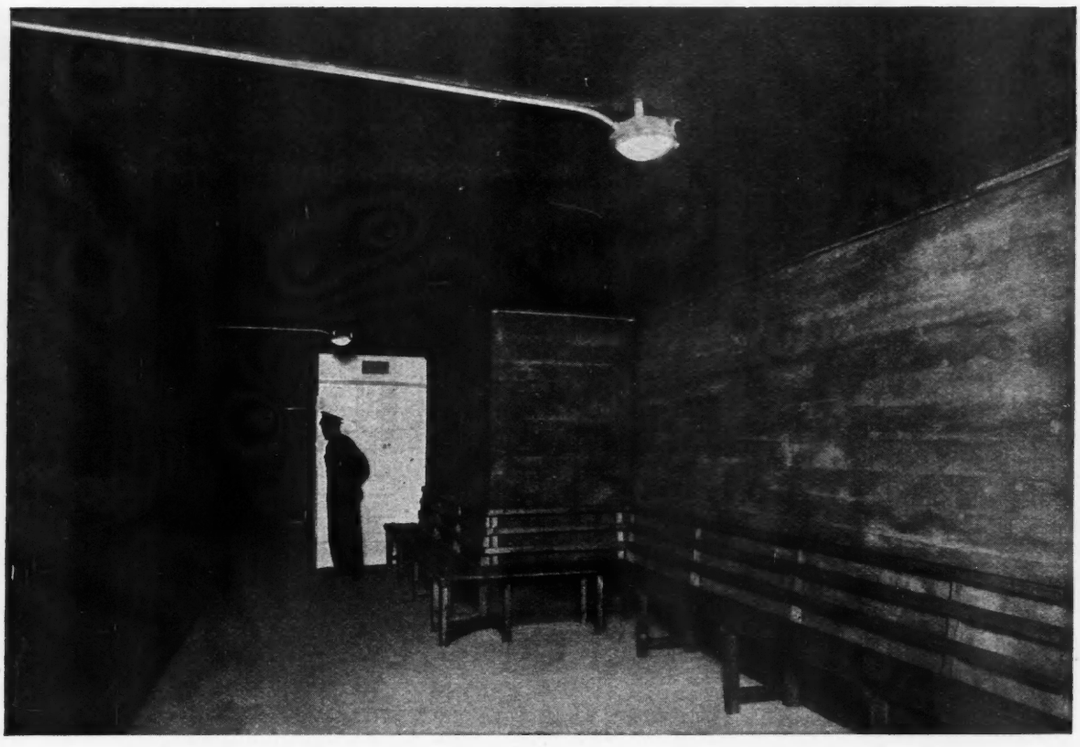
A THAMES-SIDE SHELTER USING PRE-CAST REINFORCED CONCRETE CURVED UNITS.

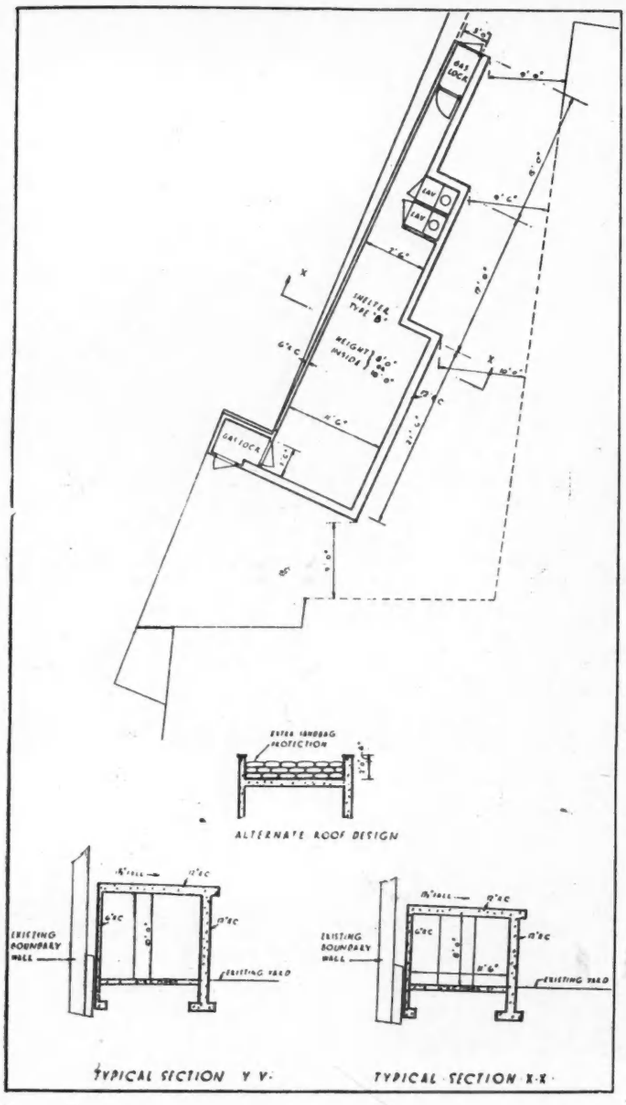
Curved precast units of reinforced concrete, 18 in. wide, were used to construct two underground shelters adjoining an important Thames-side oil depot. The exterior photograph shows one of the four entrances, each of which is fitted with an airlock. Ventilation and gas filtration plant ensure a constant supply of fresh air for the 300 occupants in time of emergency.





Left: THE EXTERIOR VIEW.
Above: INTERIOR OF SHELTER.





AN ALL-CONCRETE SHELTER FOR A RUGBY BUSINESS HOUSE.

An interior view, plan and sections of an all-concrete shelter for 50 persons in the courtyard of a Rugby business house are shown on this page. A special feature of this shelter is the double roof. The walls are carried above the main concrete roof to support an additional covering of cement-asbestos sheeting, the space between the two roofs being filled in with sandbags.

Following are details of shelter: Internal perimeter, 119 ft. Inside surface area, if 10 ft. high, 1,190 sq. ft. Floor area, 360 sq. ft.

For 10 ft. inside height, unventilated capacity is 25 persons at 75 sq. ft. For 10 ft. inside height, ventilated capacity is 48 persons at 7½ sq. ft.

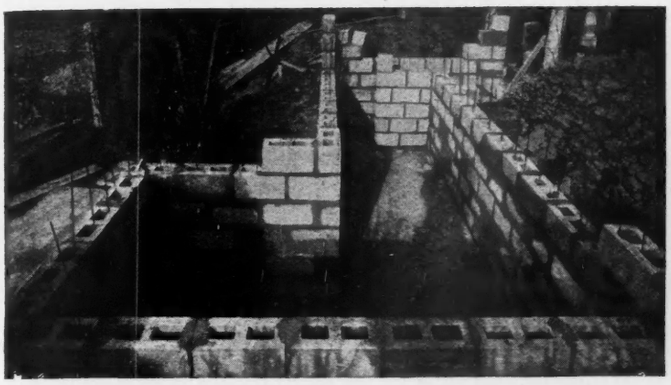
For 8 ft. inside height, unventilated capacity is 22 persons at 75 sq. ft.

For 8 ft. inside height, ventilated capacity is 48 persons at 7½ sq. ft.

Left: PLAN AND SECTIONS.

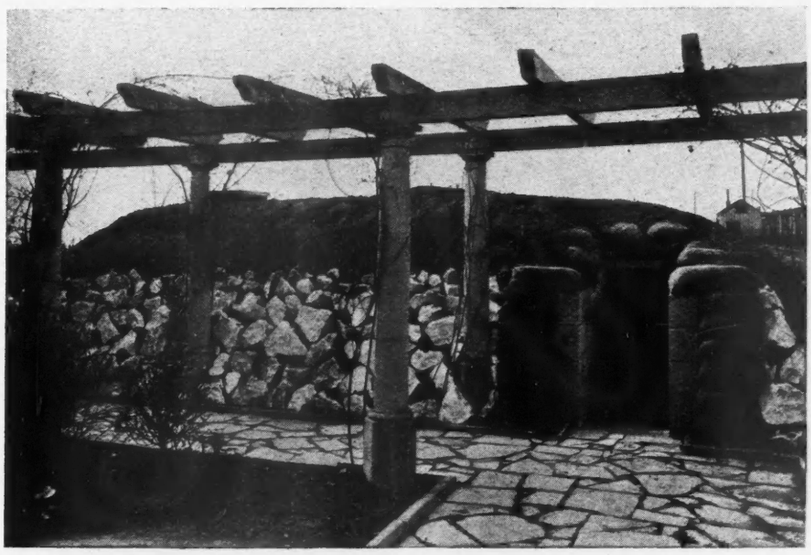
AIR RAID PRECAUTIONS

AN EFFECTIVE SHELTER AS ON VIEW AT OUR WORKS



Commencement of formation of walls. Reinforcement bars are threaded through hollow blocks—after grouting up, a wall 7" thick of solid reinforced concrete is formed.

View with portion of roof in position—for this specially reinforced concrete beams are used, with slabs from our pressure plant.



Completed shelter with earth covering.

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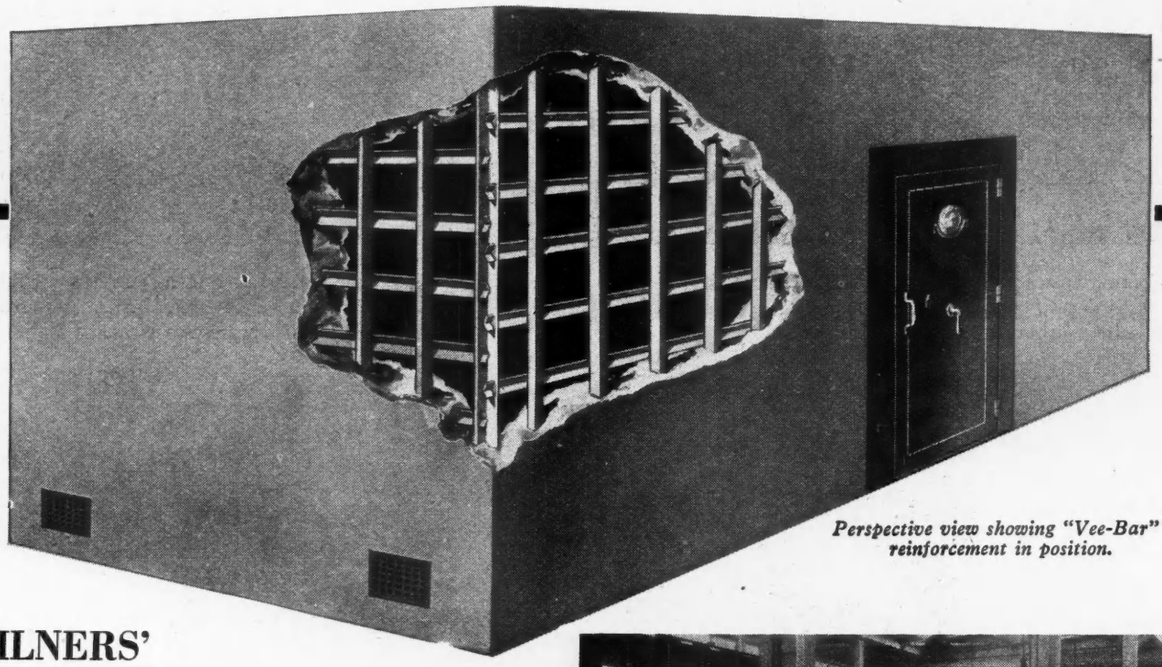
The great practical experience of Milners' in combating all known risks is an asset of incalculable value, and technical experts are always available to discuss security problems with those in positions of responsibility.



Perspective view showing "Vee-Bar" reinforcement in position.

MILNERS' "VEE-BAR" STRONG ROOMS

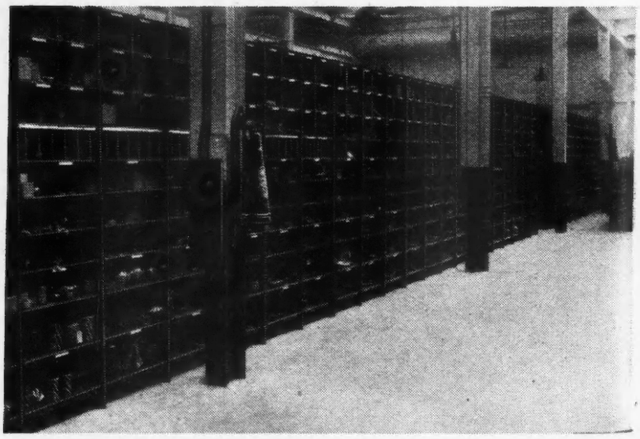
MILNERS' "VEE-BAR" Construction is the most efficient and inexpensive form of reinforcement for Concrete Strong Rooms that has yet been devised. It is particularly suitable for large firms and in all situations where there is danger from fire and explosion.

The "Vee-Bar" Room can be embodied in the construction of the building or ***can be erected as an inner lining to an existing room whose strength is not considered adequate.***

The reinforcement consists of $2\frac{1}{2}$" x $2\frac{1}{2}$" x $\frac{1}{4}$" steel angles placed horizontally and vertically at 9" centres, thus forming a mesh of approximately 6" square over the entire superficial area of the room. This reinforcement adds enormously to the strength of the roof, where great strength is essential in order to withstand the violent shock to which it would be subjected in the event of the collapse of the superstructure due to fire or the blast from an explosion.

The weight of the reinforcement is approximately 16 lbs. to the square foot and the method of erection can successfully be carried out by the Contractor from our instructions. Strong Rooms of this description are usually built without foundations, straight from a prepared floor.

Quotations will gladly be submitted, and the fullest technical assistance is available to all Builders and other inquirers.



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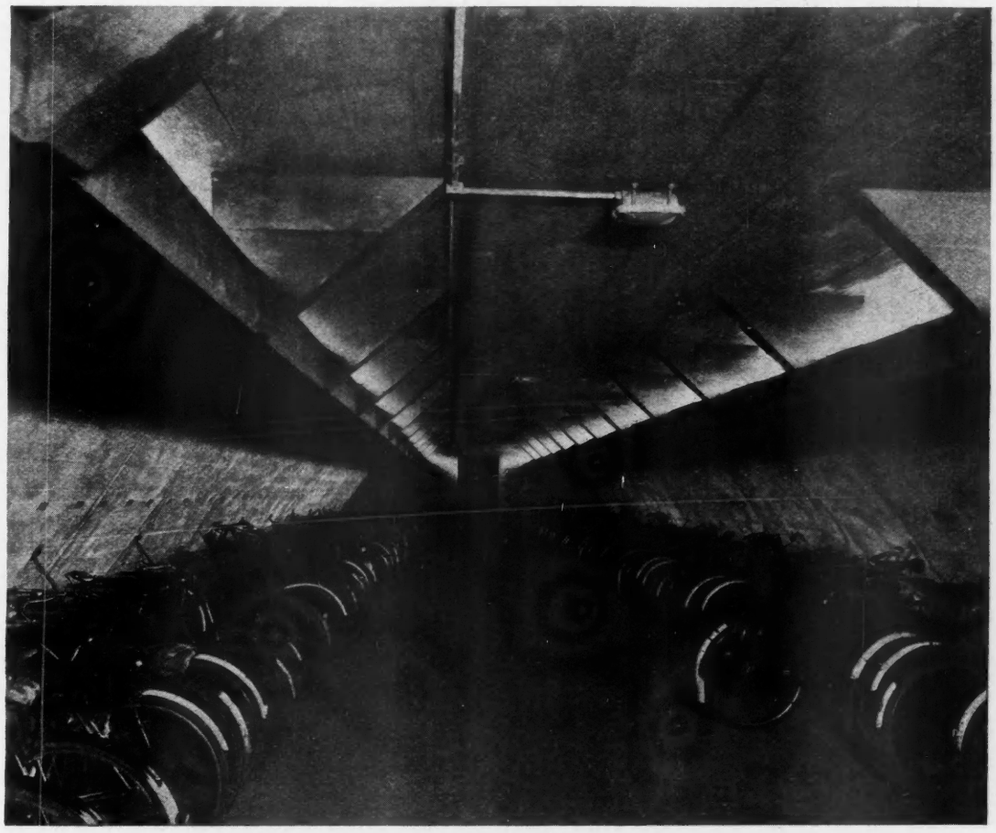
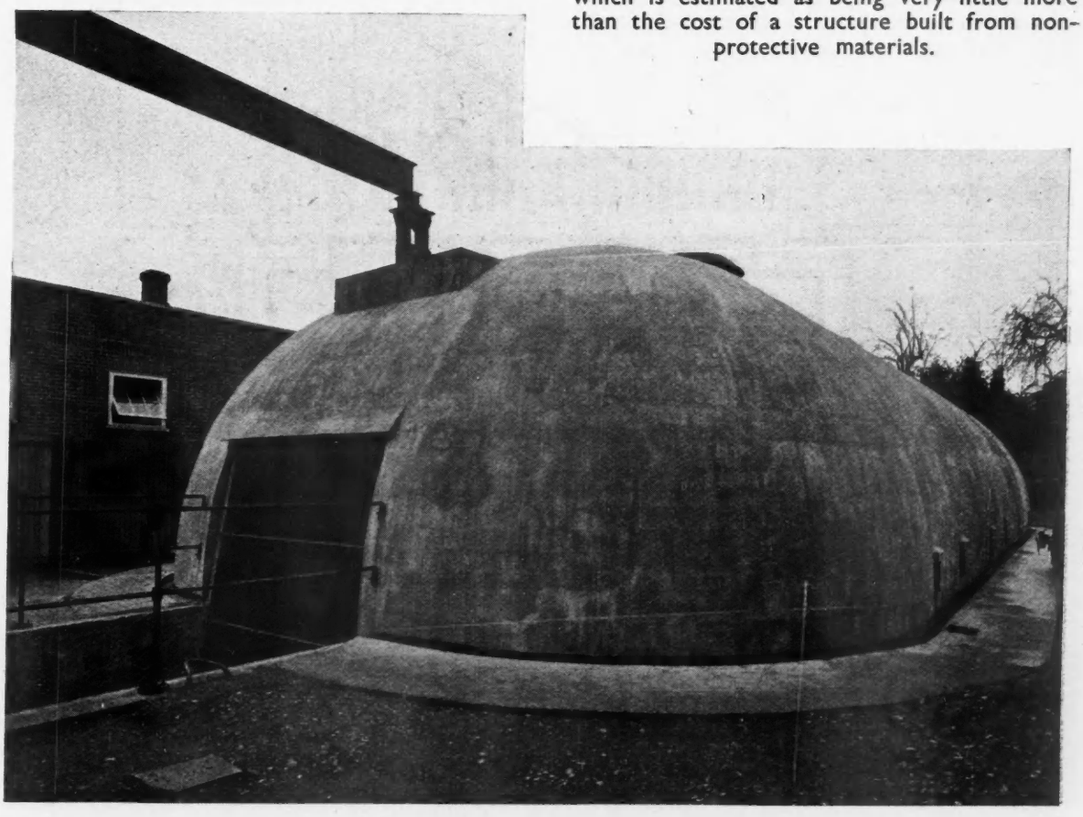
A REINFORCED CONCRETE "DUAL-PURPOSE" SHELTER



This is an excellent example of the dual-purpose shelter. Used as a cycle shed in normal times, this reinforced concrete shelter—21 ft. wide and 75 ft. long—can accommodate 160 persons in an emergency.

PROTECTION FOR ESSENTIAL SERVICES: ELECTRICITY SUB-STATION.

This reinforced concrete electricity sub-station at Watford has been designed to protect machinery worth £15,000 from everything but a direct hit. It cost £2,100 to construct, a figure which is estimated as being very little more than the cost of a structure built from non-protective materials.



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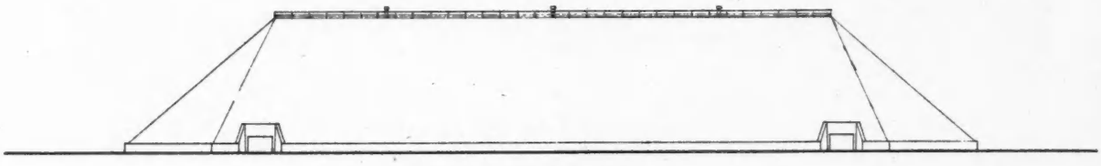
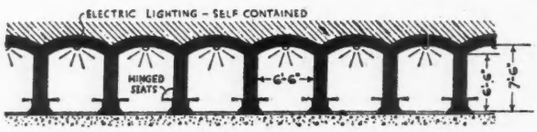


ELEVATION

- NO STAIRS; NOTHING BELOW GROUND.
- UNOBSTRUCTED AND AMPLE ENTRANCES AT ALL FOUR CORNERS ON THE GROUND LEVEL.



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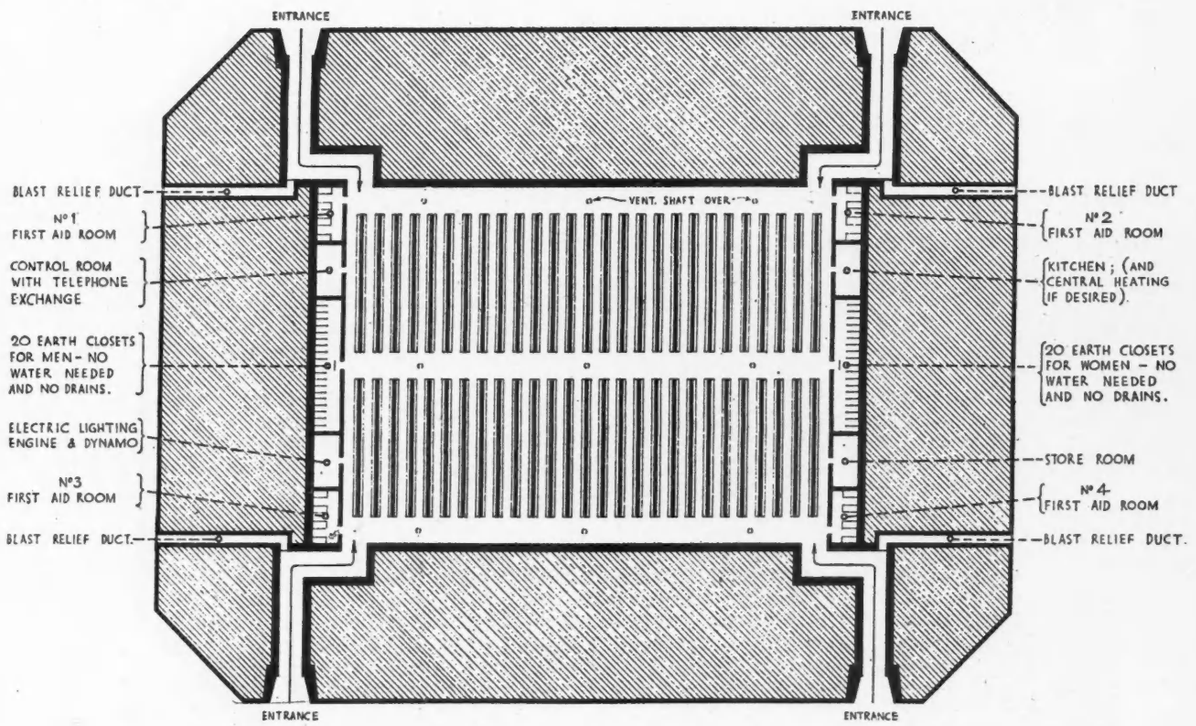
ENTRANCE
ENTRANCE
BLAST RELIEF DUCT
VENT. SHAFT OVER
BLAST RELIEF DUCT
No 1 FIRST AID ROOM
No 2 FIRST AID ROOM
CONTROL ROOM WITH TELEPHONE EXCHANGE
KITCHEN; (AND CENTRAL HEATING IF DESIRED).
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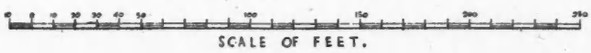
20 EARTH CLOSETS FOR WOMEN - NO WATER NEEDED AND NO DRAINS.
ELECTRIC LIGHTING ENGINE & DYNAMO
STORE ROOM
No 3 FIRST AID ROOM
No 4 FIRST AID ROOM
BLAST RELIEF DUCT.
BLAST RELIEF DUCT.
ENTRANCE
ENTRANCE

GROUND PLAN.



SCALE OF FEET.

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TOTAL AREA OF SHELTER = ONE ACRE.
TOTAL AREA OF MOUND = THREE ACRES.
56 TUNNELS INTERCONNECTED BY THREE TRAVERSE TUNNELS GIVE 30,000 SQFT. OF CLEAR SPACE FOR SAFE SHELTER OF 5000 PEOPLE. DEPTH OF EARTH COVER = 30 FT.
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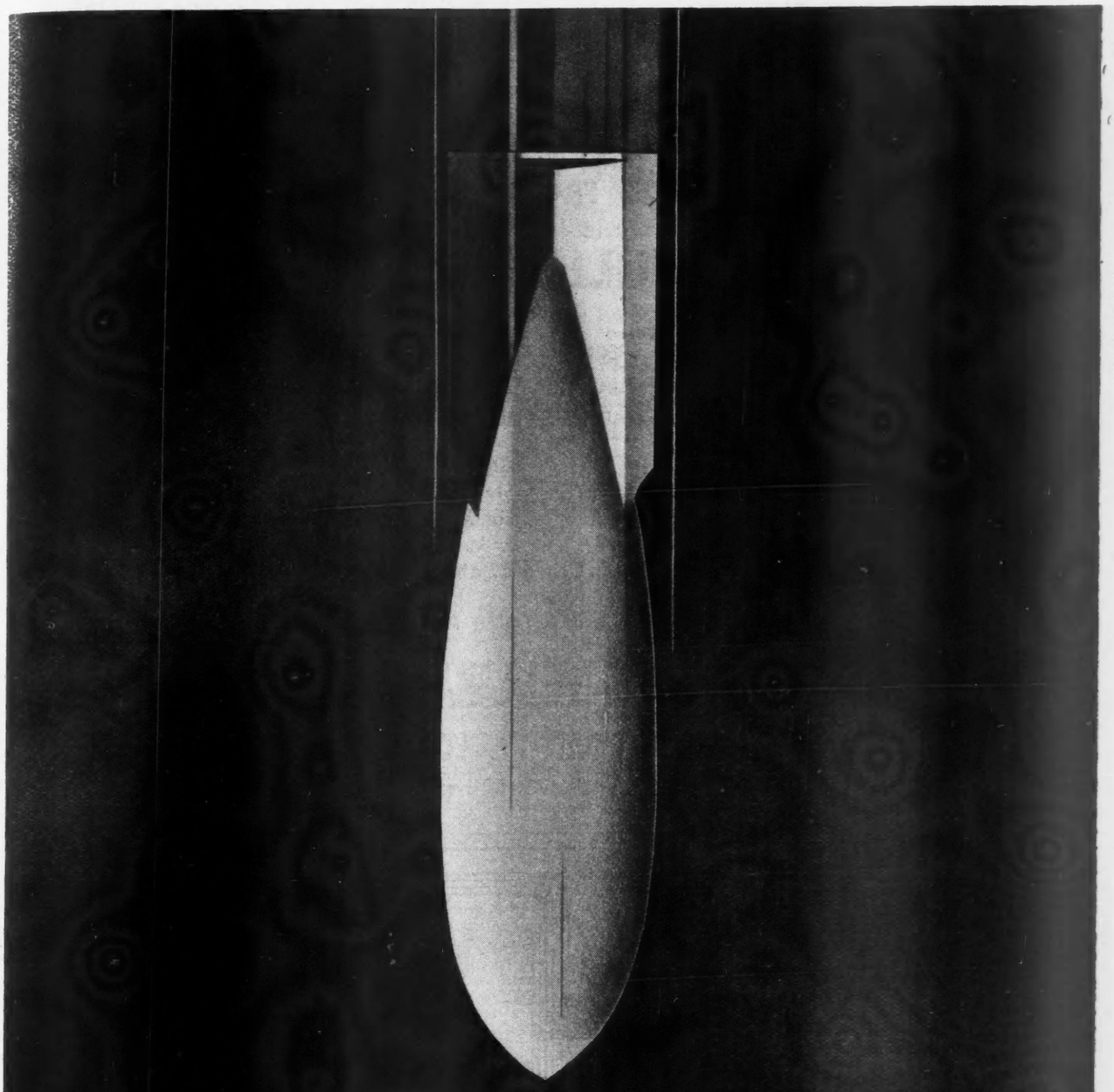
AN OVERGROUND BOMBPROOF SHELTER.

DESIGNED BY MR. H. CHARLES ERITH, M.I.MECH.E. MESSRS. B. S. HUME AND R. C. ERITH, AA.R.I.B.A., CONSULTING ARCHITECTS.



MR. A. KIRKWOOD DODDS, M.C., F.S.E., M.I.Struct.E., was the first British qualified structural engineer to make an official survey of the Barcelona air raid shelters. Bradfords have enlisted his unrivalled experience and technical knowledge by appointing him their A.R.P. consultant.

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THE PENETRATION OF BOMBS

CIVIL ENGINEERS' MEMORANDUM.

Memorandum No. 2 of the Engineering Precautions (Air Raid) Committee of the Institution of Civil Engineers deals with the penetration of bombs.

The memorandum points out that the penetration of a bomb falling with a given velocity depends very largely on its sectional density or the ratio of its weight to its maximum cross-sectional area. Since the steel case of a bomb has a much higher density than its high explosive filling, the sectional density depends on the charge/weight ratio, or the weight of explosive expressed as a proportion of the total weight of the bomb. Diagrams are given of the variation of sectional density with the charge/weight ratio, and of the way in which the charge/weight ratio varies with the relative thickness of the bomb casing.

The penetrative power of any given bomb depends on its striking velocity, and for any bomb there is a terminal velocity at which the air resistance is equal to the weight of the bomb. Approximate terminal velocities are given for bombs of different sectional densities, and it is considered possible that the terminal velocity for a bomb of high sectional density might be as much as 1,500 feet per second, though such a velocity could only be reached in practice if the bomb were dropped from a height of 40,000 or 50,000 feet The practical upper limit for the arrival velocity of a very heavy bomb of high sectional density is probably about 1,200 feet per second. At the other end of the scale a small incendiary bomb, with a low sectional density, might have a terminal velocity no higher than 400 feet per second, and this terminal velocity would be easily reached in practice.

Depths of Penetration.

The depths of penetration for a number of different materials are shown diagrammatically for a bomb of unit sectional density. The actual depth for any bomb is obtained by multiplying the unit depth by the appropriate value of the sectional density. As an illustration of the actual results indicated by a diagram, a small incendiary bomb with a sectional density of ½ lb. per square inch, and an arrival velocity of 400 feet per second would penetrate concrete (of medium strength) to a depth of about 1 inch, and alternatively sand, gravel or earth to a depth of about 1 foot. A 500 lb. bomb with a charge/weight ratio of 40 per cent., or a 2,000 lb. demolition bomb with a charge/weight ratio of 55 per cent. might be expected to have a maximum depth of penetration of 2 feet 6 inches in concrete of medium strength, and, alternatively, of a little over 20 feet in sand or gravel.

The maximum vertical depth into the ground which could be reached by a 2,000 lb. bomb of high sectional density specially designed for good penetration (and therefore containing only a small proportion of high-explosive), is estimated as being unlikely to be more than 50 or 60 feet. This estimate, however, is not to be taken as indicating the depth of earth cover required for protection against such a bomb, as it does not include an allowance for the disruptive effect of the explosion.

Pamphlet copies of this memorandum are obtainable from Messrs. William Clowes and Sons, Ltd., 94, Jermyn-street, London, S.W.1, price 6d., post free, as well as pamphlet copies of Memorandum No. 1, "Blast," price 6d., post free.

EMERGENCY SHELTERS IN THE HOME

AN ARCHITECT'S SCHEME.

Mr. John Murray, F.R.I.B.A., F.S.I., M.I.Struct.E., the architect and adviser to the Commissioners of Crown Lands, has produced a scheme of deep shelters for large numbers of people. Mr. Murray contends that strutting and shoring up basements in houses is not sufficient to withstand the effect of high-explosive bombs, but by lining the walls and ceilings of basement walls with poured concrete walls and thick ceilings with steel diaphragms in their thickness, basements in London houses could be made to afford better protection.

The scheme of Mr. Murray and an engineer, Mr. W. Duncan, consists of utilising one or two rooms in the basement of a house (even coal-cellars or vaults under pavements adjoining can be utilised). A set of steel panels is put in position a foot away from the existing walls, and between the steel panels and the walls is inserted a dovetailed steel diaphragm. Steel rolled joists and the ceiling panels are put up in position, and two dovetailed steel diaphragms are put between the existing ceiling and the new steel ceiling panels. The next operation is inserting the shelter door, which is made in the form of a steel envelope with a steel diaphragm in the centre and swung inwards, moving in ball-bearing hinges with a special locking device. Liquid concrete, ready mixed, is delivered at the door of the house, and an armoured hose is connected and the concrete poured into the space between the panels and the existing walls and ceiling and into the top of the opening of the envelope door.

When the concrete is set, in about 1½ day, the panels are taken down and the basement air-raid shelter is complete. These shelters are claimed to be permanent, damproof and fireproof.

Competition for a Shelter.

The Air Raid Protection Institute invite designs in competition for a blast- and splinter-proof air raid shelter to hold some 50 persons. The assessors are Messrs. Frank Cox, C. F. de Steiger, C. W. Glover, A. H. Moberly and G. R. Falkiner Nuttall. A prize of £105 is offered. Designs must be submitted by May 8 to the Secretary, 2, Millbank House, S.W.1, from whom conditions are available on deposit of £1 1s.

AIR RAID PROTECTION INSTITUTE

PRESIDENTIAL ADDRESS.

Mr. Oliver Simmonds, M.A., F.R.Ae.S., M.I.Ae.E., M.P., President of the Air Raid Protection Institute, delivered his Presidential Address at a general meeting held on Tuesday, March 14.

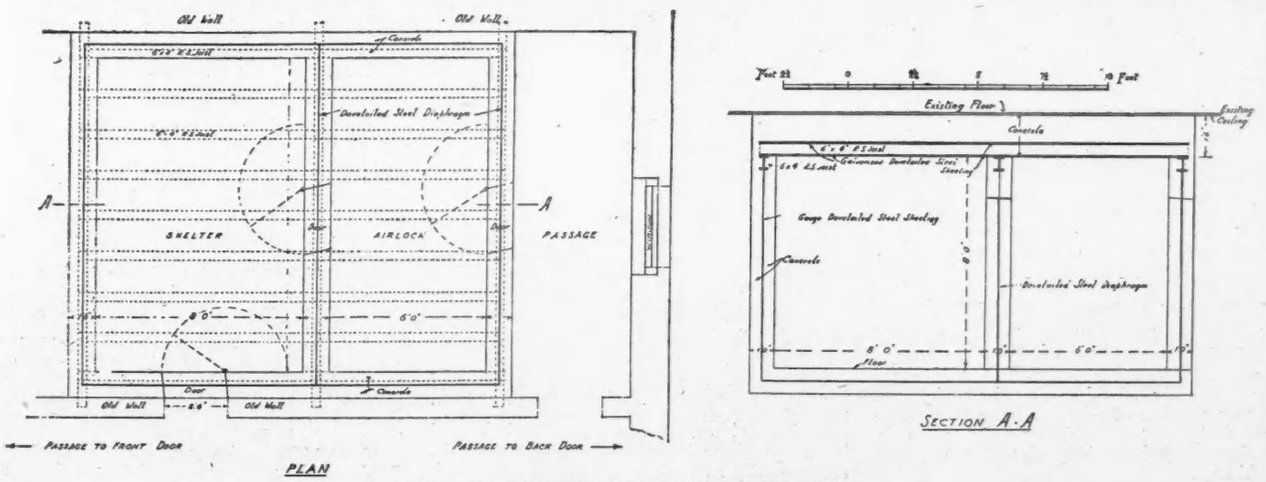
Mr. Simmonds, following some introductory remarks, spoke of the protective habit of mind and said: "The first essential with regard to civil defence, if it is to become nation-wide in its conception, is to make and find acceptance for this statement—civil defence is primarily a protective habit of mind."

He then went on to give an analysis of the protective habit of mind, dividing the subject into various aspects, the first and most important being that of location.

The speaker continued: To any student of civil defence the question of location may seem to be so obvious as not to need any discussion, but when one hears of local authorities about to erect blocks of flats immediately adjacent to military targets, it becomes obvious that the world carries no such consideration in mind. Let it be said, therefore, that the question of location is of fundamental importance in civil defence. Three comparative degrees of vulnerability arise from the division of the country by the Ministry of Health into evacuation, neutral and reception areas, but within any of these sub-divisions there may be, and in very many instances will be, places or areas in the highest degree liable to attack. These will be referred to as target areas. From the point of view of civil defence, these must comprise both legitimate military targets and other non-legitimate targets which, nevertheless, may be singled out for attack by aircraft. So far as commerce and industry are concerned in the target areas, these are likely to be completely disorganised, perhaps almost stopped, during the initial weeks of war; their continuation in the target areas during the war may be so hazardous as to be unattractive. In these circumstances the protective habit of mind will urge that those responsible for commerce and industry in these areas shall make arrangements now to transfer their activities during war to an area in a lower category of danger.

Material Protection.

The second principal aspect is material protection. The degree of protection which each individual will provide for himself will depend on the amount of money that he decides to spend, rather than on any technical assessment of danger, although men in the same financial position who live, for example, in Devonshire and Essex, will inevitably allow their respective geographical positions to determine the extent of their willingness to spend money on this protection. The protective habit of mind will in most cases urge some form of shelter, which can properly vary from a stronghold in target and evacuation areas to the lightest types of splinter-proof



EMERGENCY SHELTERS IN THE HOME. (SEE ABOVE.)

construction in the reception areas. In cost these will vary from £100 to £1 per head. This elementary precaution will gain a great fillip now that those who are in insurable occupations are receiving the Government's free-issue shelter.

Although a shelter be constructed, this must certainly not be accepted as a fulfilment of all rational obligations under this head. The reduction of inflammability of all buildings is of the utmost importance. It will be recalled that the official clearing of all attics and lofts in Hamburg revealed the presence there of no less than 400 tons of highly inflammable material. If it be understood that insurance will not be able to pay for 100 per cent. of air-raid damage, it becomes essential, even from the basest motives of self-interest, to reduce the fire hazard to a minimum by the destruction now of this unnecessary and dangerous litter. In the industrial sphere, compulsory shelters appear to be no far distance from us, but the protective habit of mind will in very many cases not be satisfied with the official minimum standard of protection.

The Technician's Responsibility.

With regard to material protection, architects and engineers have a very special responsibility to their clients. Members of this Institute in these professions are exercising vigilance on this matter, and drawing the attention of their clients to the importance of giving this subject the most careful consideration. Some clients, however, still refuse to understand that this matter is of any importance. Most men and women who are studying this subject are agreed that building construction will have, at an early date, compulsorily to adhere to the minimum standard of civil defence. Thereafter it will not be long before these standards are applied to all buildings in vulnerable areas. The first scapegoats of their owners will be the professional advisers of their construction. It is thus of the greatest importance, both to their clients and to themselves, that all architects and engineers should formally draw the attention of those constructing buildings to the necessity of considering civil defence, and the advantages of incorporating such precautions as are deemed wise in the building at the time of construction. The worst error, however, is to construct in target areas the lighter and cheaper type of shelter. These will only be a source of disillusionment and death.

A third aspect is duplication. This principle is well recognised in all forms of offence and defence. In civil defence, for example, it is well recognised that underground shelters and strongholds should have more than one exit. For fire fighting, in addition to the supply of water from the mains, a second source is regarded as essential. But, in fact, the principle of duplication has the widest ramifications, which are only faintly understood and heeded. Further examples in different spheres show how vigilant must be the protective habit of mind if we are to avoid the commission of folly. In many parts of the country level-crossings are being replaced by adjacent bridges, and the level-crossings are being destroyed. As railway bridges in the open country may well be bombed, it would be wiser to allow the level-crossings to remain *in situ* beside the bridges that replace them.

Again, in areas where new sewage systems are being constructed, septic tanks previously utilised are frequently destroyed or cut off. The principle of duplication should show that it is wiser to retain the old system and to cut it off by a small sluice-gate which could be opened in the event of the main sewage system being bombed and rendered unusable.

REINFORCED CONCRETE SHELTERS.

For a number of illustrations reproduced in this Supplement we are indebted to the Cement and Concrete Association, which has issued recently a publication in which are shown a number of reinforced concrete structures designed to afford protection not only for human beings but also for essential machinery.

CONDENSATION IN UNDERGROUND SHELTERS

By A SPECIAL CORRESPONDENT.

ALTHOUGH the causes and effects of condensation are well understood and have been taken count of in much that has been written upon the subject of air raid shelters, recent experience has shown that many people who, it may be presumed, are aware of the general principles concerned, are apt to overlook its possibilities in their particular cases—perhaps because their anxieties are about the greater dangers.

Such questions must arise in all shelters that are capable of being sealed against the entry of gas, unless they be built of porous materials such as bricks, but will be less acute in those above ground, or that are sunk in dry chalk or well-drained sandy subsoils. Even if a shelter is too shallow to reach the subsoil water level, damp earth in contact with the outer surfaces of the structure will rapidly and continuously rob it of heat. Most shelters will be formed either of dense concrete made with impervious aggregate, or of sheet steel in various forms, with or without an outer casing of such concrete. In all such cases the inner surface is almost, if not entirely, incapable of absorbing moisture, and is kept cold—even when in contact with warm air—because of the rapid flow of heat into the surrounding ground.

Consider, now, that when an air raid occurs, the shelter will be crowded by people whose body heat will raise the temperature of the air, and whose breath and perspiration will add considerably to its moisture content. The warmer the air, the more moisture it can hold in suspension, but when the air reaches the limit of saturation it will no longer take up moisture which would normally be evaporated from the body, and as such evaporation is the chief means by which the excess heat of the body is dissipated, the occupants will, at this stage—or even before it is reached—be bathed in perspiration and in a state of acute discomfort, predisposing them to panic.

As ventilation will be at a minimum, or entirely absent, the only other means by which this excess moisture can be removed from the air, if artificial air-conditioning be excepted, is by its condensation upon the cold inner surfaces of the shelter. Such condensation therefore serves a useful function, and it is for this reason that the internal surface area (floor walls and ceiling) has been fixed at a minimum of 75 sq. ft. per person for unventilated shelters. Unfortunately a good deal of this condensed moisture will be taken up again by the warm air, and it will add greatly to the comfort of the occupants if it can be absorbed by porous linings to these internal surfaces. Where cost permits, an inner lining of bricks of the most porous type available would be preferable, and this inner shell could, perhaps, form the permanent centering for the structural concrete, but in the majority of cases the absorbent lining will have to be applied after the completion of the structure.

A number of materials suggest themselves for this purpose, as, for instance, a weak cement mortar made with pulverised diatomaceous brick, or pumice, in place of sand, or even a thick plastering of fine coke breeze and cement, but in the writer's experience the best results are likely to be obtained by a thick plastering formed in several layers with 3 parts of granulated cork sifted through a ¼-in. sieve, to ¾ part of fine sand and 1½ parts of Portland cement. If pieces of cork larger than ¼-in. are included these are likely to bounce off from the wall when the pressure of the laying-on trowel passes from them, and experiment has shown that the inclusion of the small proportion of fine sand helps to prevent this happening with the smaller particles, and facilitates the application. The granulated cork can be obtained in small quantities, almost for the asking, as it is used in the packing of imported grapes, and fruiterers usually have no further use for it. Failing this there are the usual commercial sources of supply.

It is desirable that prior to the forced occupation and closing up of a shelter the ventilation should be as brisk as possible, and that provision should be made for this, so as to prevent a humid condition of the air prevailing at the commencement of such occupation, because the drier the air is inside the shelter, and the less the amount of water on its interior surfaces, the longer will be the time for which the shelter can be occupied without the conditions becoming unbearable.

When all has been said and done, it should be realised that except in very large shelters equipped with adequate filtration and air-conditioning plant, some degree of condensation and discomfort must be tolerated, but such are minor ills compared with those from which they form a refuge.

A.R.P. SCHEMES

WORK IN PREPARATION.

BATH.—The T.C. have resolved to accept the tender at £2,420 10s. of the Bristol Stone and Concrete Co., Ltd., for the supply and delivery of concrete units required in connection with the completion of 12 trenches. The City Engineer has reported that he will fit the units and complete by direct labour.

BEDDINGTON AND WALLINGTON.—T.C. has instructed the Borough Surveyor to prepare plans and estimates for the provision of another cleansing station at the Bute-road depot.

CRAYFORD.—The A.R.P. Committee have resolved that by way of experiment the following tenders for concrete trench linings be accepted: Lewis Construction Co., Hayes, 25 yd. at 46s. 6d. per yd.; Hall and Co., East Dulwich, 25 yd. at 52s. 3d. per yd.

EXETER.—Provision has been made in the estimates of the A.R.P. Committee for an expenditure of £20,000.

GATESHEAD. — T.C. are to construct trenches to cost £17,700.

HENDON.—It has been recommended that, subject to the approval of the Home Office, the Borough Surveyor be authorised to convert the trenches in Hendon-grove in accordance with his scheme of steel construction by way of experiment at an estimated cost of £700, and also to construct as a further experiment a section on the alternative lines proposed at an estimated cost of £85.

KENSINGTON.—Arrangements are being made for the completion of trench accommodation at an estimated cost of £13,500. It has been recommended by the A.R.P. Committee: (i) That the tender of Messrs. Percy Trentham, Ltd., at £7,869 0s. 3d. be accepted for lining trenches in Kensington Gardens (north and south), and that authority be given for extra works estimated at £492; (ii) that the tender of Messrs. Percy Trentham, Ltd., at £1,537 6s. 3d., be accepted for lining trenches in War Memorial Playing Fields and Arundel Gardens, and that authority be given for the cost of surface reinstatement estimated at £200; (iii) that the tender of Messrs. A. Roberts and Co., Ltd., at £523 11s. 6d., be accepted for trench linings in Onslow-square Garden Enclosure, and that authority be given for the cost of surface reinstatement estimated at £50.

KINGSTON.—The tender of Messrs. Flooring Contracts, Ltd., 44, Grosvenor-gardens, S.W., at £3,777 17s. 6d., has been recommended for acceptance for the completion of trenches on the Fairfield Children's Playground and the Athelstan Recreation Ground.

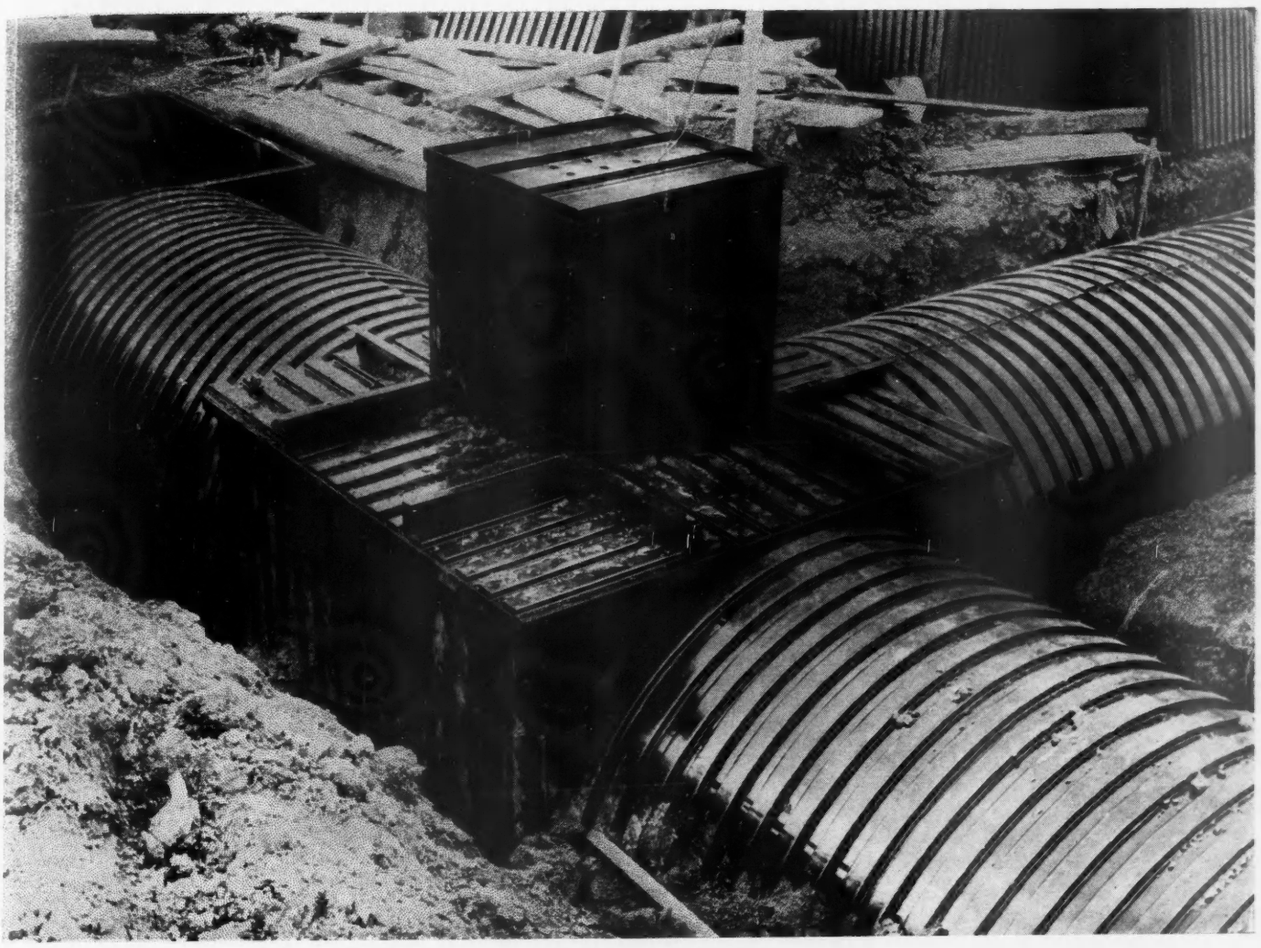
LAMBETH.—Air Raid Precautions Committee has engaged Messrs. Tecton to prepare a survey of the borough.

MANCHESTER.—The C.C. has received from its Housing Committee a proposal to add shelters to approved flats for Miles Platting and West Gorton, at a cost of £21,780.

PORTSMOUTH.—City Council has approved plans submitted by Messrs. J. Evans and Son (Portsmouth), Ltd., for 5 A.R.P. shelters in Goldsmith-avenue.

RAMSGATE.—The T.C. have decided to construct a cleansing station at the rear of Cavendish House, for the use of the police, special constabulary and War Reserve in time of emergency. The B.E.'s estimate of the cost is £3,550.

RAMSGATE.—The main portion of the T.C.'s shelter scheme, which provides for



Design to DRG. No. 898/1B. Approved by Home Office Air-Raid Precautions Dept.

LEWIS TRENCH SHELTER CONSOLIDATION

(Approved by the Home Office).

Lewis dovetail sheets are already well known for the valuable key they give to plaster or concrete. In addition, the disposition of the metal is such that the sheeting is extremely strong, and this advantage is utilized to the full in Lewis trench shelter consolidation, with the addition of a unique feature.

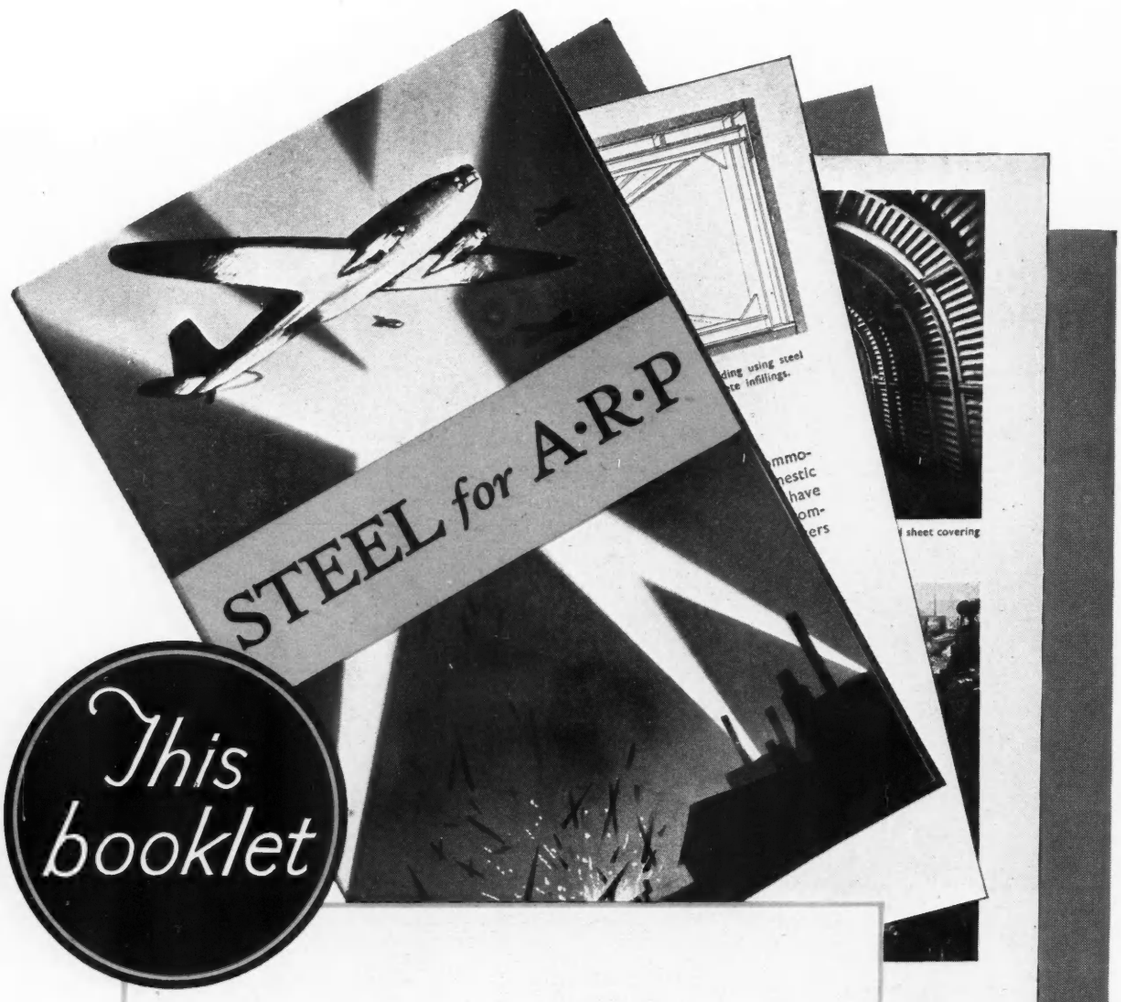
As will be seen from the photograph, the trench lining is of arch form, the arches being made up from two half-arches joined at the top. The joint employed needs no bolts or tools; the dovetail grooves are so tapered for a certain distance that when the keys of one half-arch are inserted into the corresponding grooves in the other half, they form one continuous unweakened arch.

This design has the approval of the Home Office and is available for early delivery. The photograph shows an exterior view, with an emergency exit at the intersection.

If desired, the shelter can be concreted on the outside, taking advantage of the dovetail grooves, which bond it securely to the metal.

Lewis Construction

DEPARTMENT OF STEEL CEILINGS LTD.
STELEONITE WORKS, HAYES, MIDDX.



This booklet

This 40-page booklet contains a wealth of valuable advice on the reinforcement of buildings and the construction of air-raid refuges. It will be sent to all interested on application to the Association, who also offer their advisory service.

STEEL
STRENGTH
SECURITY

THE BRITISH STEELWORK ASSOCIATION

STEEL HOUSE, TOTHILL STREET, WESTMINSTER, S.W.1

three and a quarter miles of new tunnelling, encircling the town and joining up with a disused railway tunnel, has been approved by the Home Office.

ST. MARYLEBONE. — The A.R.P. Committee are obtaining the opinion of Sir E. Owen Williams, K.B.E., as to the practicability of providing a car-park under the garden of Cavendish-square, W.1. The tender of Messrs. Diespeker and Co., Ltd., Clifton House, Euston-road, N.W.1, has been accepted at £1,079 10s. for making permanent the trenches in Regent's Park.

SOUTHALL.—The Town Clerk has submitted a communication from the Air Raid Precautions Officer of the Middlesex County Council stating that the proposal to provide a public shelter for 200 persons, at a maximum cost of £1,963, has been approved.

SOUTHWICK.—The U.D.C. have agreed to spend £969 on A.R.P. during the next financial year.

STRETFORD T.C.—The A.R.P. Committee have agreed to a suggestion as to the provision of an air raid shelter under the new public library at an approximate cost of £700, and that the County Council be approached with a view to the expenditure being treated as approved expenditure for air raid precautions purposes, and that in default of their so doing the shelter be constructed at the Corporation's expense.

SUNDERLAND.—General Purposes Committee approved £520,000 plan by B.E., Mr. J. E. Lewis, for bomb-proof shelters. T.C. will be recommended to send plan to Home Office.

WARWICKSHIRE.—The sum of £79,330 is required this year for A.R.P. purposes. The cost of making shelter trenches permanent will be £20,000.

WEST RIDING.—The Finance Committee has recommended the County Council to spend £2,000,000 on deep shelters. Mr. H. R. Hepworth, West Riding County Surveyor, is Engineer to the W. Riding A.R.P. Authority.

TENDERS ACCEPTED.

BRENTFORD AND CHISWICK.—Precast reinforced concrete revetments to trenches in open spaces, for T.C.:—

	Home Office instructions.	Design by tenderers.
West Rotinoff Piling & Construction Co., Ltd., W.C.2	£14,625 11	—
F. D. Hidden & Co., Ltd., Brentford	11,860 0	£10,180 0
Lavender, McMillan, Ltd., Worcester Park	11,467 16	—
Girlings Ferro-Concrete Co., Ltd., Feltham	11,322 2	—
Joseph Mears, Ltd., S.W.6	11,133 17	—
Wm. F. Rees, Ltd., S.W.1	11,110 9	—
Taylor Woodrow Construction, Ltd., Southall	10,873 0	—
L. J. Speight & Partners, Ltd., W.C.2	10,697 2	—
Parr-Head & Clements Knowling, W.5	10,527 0	—
W. & J. Glossop, Ltd., W.6	10,377 12	—
Alexandra Stone Co., Ltd., Kirby Muxloe	10,325 19	10,084 14
Mears Bros. (Contractors), Ltd., S.E.13	—	9,198 17
Wilson Lovatt, Ltd. (W. V. Zinn), S.W.1	—	8,868 6
W. H. Wheeler & Co., Ltd., S.E.5	—	8,715 10
Richard Costain, Ltd., W.1	—	8,290 19
Wembley Construction Co., W.5	—	8,145 10
Flooring Contracts, Ltd., S.W.1	—	7,816 10
Howard Farrow, Ltd., N.W.11	10,131 13	—
Demolition & Construction Co., Ltd., S.W.1	£9,823 11	—
John Ellis & Sons, Ltd., Leicester	9,792 8	—
Geo. Wimpey & Co., Ltd., W.6	9,692 16	—
Leightons (Engineers), Ltd., S.W.1	9,300 16	—
Percy Bilton (Roadways), Ltd., W.1	9,231 0	—
Helical Bar & Engineering Co., Ltd., S.W.1	9,209 1	—
Walter Smith (Public Works), Ltd., Riverhead, Kent	8,579 5	£7,855 10
Wates, Ltd., S.W.16	8,511 0	—
Stent Precast Concrete, Ltd., S.W.1	—	7,787 4
Trevor Construction Co., Ltd., S.W.1	—	7,764 15
John Mowlem & Co., Ltd., S.W.1	—	7,611 12
J. Smithers, N.20	7,850 19	7,150 0
D. G. Somerville & Co., Ltd., S.E.14	7,705 16	—
Rumney Gibson, Ltd., Harrow	7,178 4	—
A. O. Laird, Ltd., 12, Buckingham-st., W.C.2	*6,795 18	6,506 0
Borough Surveyor's estimates—		
Home Office schedule		8,822 0
Borough Surveyor's estimate		9,450 0

EPSOM AND EWELL.—1,200 yds. of air-raid shelters on 6 different sites, for T.C. N. Auty, A.M.Inst.C.E., B.E.:—*M. J. Gleeson, Ltd., London-rd., N. Cheam, £3,368 7s. 1d.

A.R.P. CONTRACTS OPEN.

The following local authorities are among those inviting tenders for A.R.P. materials, details of which will be found in the main issue under "Contracts Open": Hayes and Arlington U.D.C.; Orpington U.D.C.; Ruislip-Northwood U.D.C.; Salford T.C.; Wandsworth B.C.; and York T.C.

Poplar's Schemes.

The Poplar Borough Council A.R.P. Committee has recommended that the Borough Engineer and Surveyor be instructed to proceed with the construction of underground Wardens' posts at an estimated cost of £2,975. The Borough Engineer and Surveyor has also been instructed to proceed with the construction of a Report Centre at an estimated cost of £828. A scheme for a subsidiary report centre on the Isle of Dogs is being prepared and consists of the adaptation of a portion of the basement of the Cubitt Town Library. In connection with bomb-proof shelters, the committee have submitted to the Home Office plans prepared by the Borough Engineer and Surveyor showing a suggested method of layout and construction of a deep bomb-proof shelter which would provide accommodation for 3,000 persons. The Committee have also approved lists of emergency orders and requisitions of the several departments and have approved the obtaining of 100 yards, at £2 12s. per yard, precast concrete lining from Messrs. Diespeker and Co., Ltd.

Islington B.C. Appoint Architects.

Islington Borough Council has decided that Messrs. Tecton, 57, Haymarket, S.W.1, be appointed as architects for the purpose of carrying out a comprehensive survey of the borough and preparing a scheme for the construction of deep shelters, at a fee of £1,500.

SHELTERS AND EQUIPMENT

A GARDEN SHELTER.

An interesting type of shelter has been designed and constructed at the works of Messrs. Trent Concrete, Limited, Colwick, near Nottingham. The shelter is partly underground, the excavated earth being used partly as a covering on the roof. The height inside is 6 ft. 5 in. and the width between walls 4 ft. 8 in. The walls are constructed of hollow concrete blocks, threaded with reinforcement rods and grouted up solid, so that 7 in. thickness of reinforced concrete is formed. For the roof structure reinforced concrete beams and slabs are used and a ventilator is embodied in the design. Constructional views are on this page.

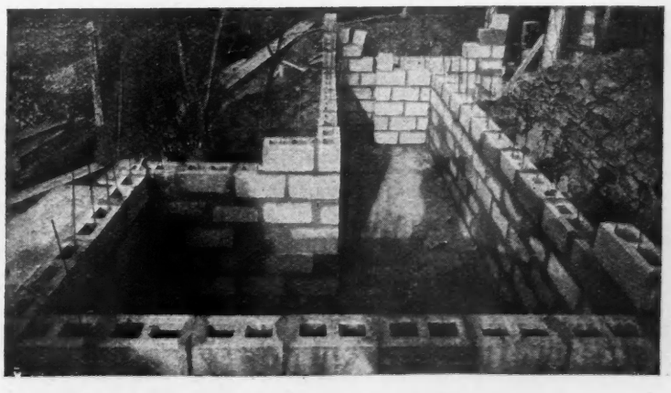
In order to illustrate how the shelters can be made a pleasing addition to a garden, Messrs. Trent Concrete have made an attractive rockery in the earth covering the shelter. The firm welcome inspection of the shelter at any time by appointment.

"SINGLUNIT" TRENCH LINING.

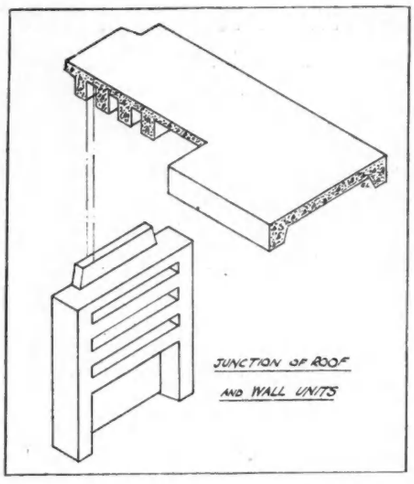
The method of lining air raid trenches with pre-cast reinforced concrete units shown in illustrations on page xxxiv, has recently been patented by Mr. T. F. Burns, A.M.Inst.C.E., A.M.I.Struct.E., and is now on the market under the name of "Singlunit." Its main feature is that for the straight run of trench only one type of unit is necessary, it being capable of use for the walls, roof and for the floor if a pre-cast one is desired. Alternatively, it is quite suitable for use with a cast *in situ* floor. Another feature of the invention is that the units are so formed that the width of the lining can be arranged in five different widths, with the Home Office width of 4 ft. 8 in. as a minimum and 5 ft. 10½ in. as a maximum, in stages of about 3 in. This feature should be appreciated by local authorities where the trenches have been already dug to widths greater than the minimum Home Office requirements, as well as by industrial undertakings where the greater widths obtainable mean that protection costs per head will be lower.

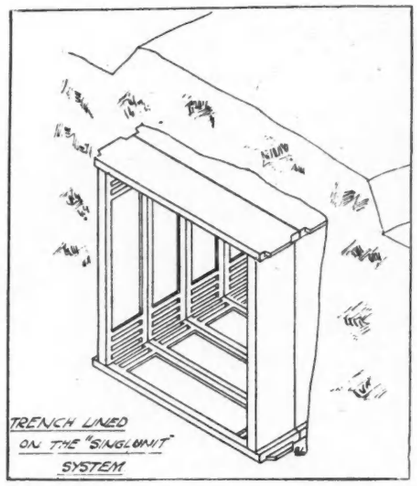
The unit is 18 in. wide and about 6 ft. 8 in overall, and the cross-section is the trough form so common in floor work. The ends of the unit have a tongue about 12 in. wide, which engages in slots formed in the web near the ends of the unit. The width of the lining is only dependent upon interengagement of the units; thus, if the Home Office minimum width is required the wall units are placed with their tongues engaged in the first pair of slots, whereas if wider linings are required the appropriate slots are used. In the minimum width the roof units will overlap at each end.

The design is suitable for any ground likely to be met with in trench construction, and it is claimed to be economical. One further point of interest is that where the pre-cast floor units are used the trough is, of course,



A GARDEN SHELTER NEAR NOTTINGHAM. (SEE THIS PAGE.)





THE "SINGLUNIT" TRENCH LINING. (SEE PREVIOUS PAGE.)

on the inside and can conveniently be used to drop in duck-boards when the emergency arises—a useful feature where trenches are situated in badly drained ground.

Junctions of trenches are dealt with either by *in situ* concrete or by the addition of one more unit which spans across the intersection. Emergency exits or manholes are dealt with by one further type of unit, which incidentally can be placed in any position at will. It is claimed that by the elimination of many types of moulds the units can be manufactured at competitive rates, and that erection costs are reduced to a low figure.

We are informed that the system has been approved by the Home Office for A.R.P. trench lining and that it is now being manufactured under licence in most parts of the country.

AN A.R.P. BROCHURE.

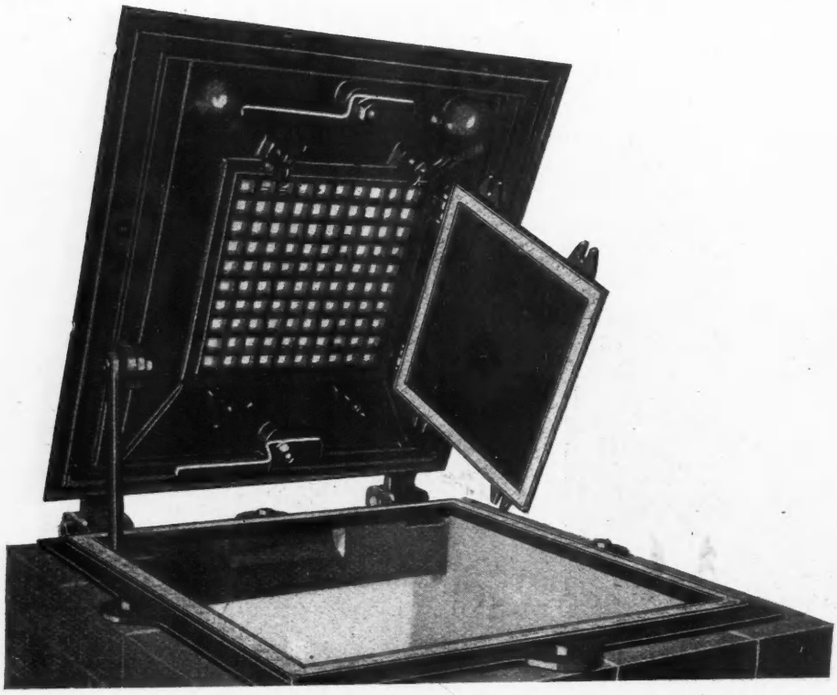
Steel air-raid shelters are the chief feature of a recently published brochure dealing with the A.R.P. products of Messrs. Frederick Braby & Co., Ltd., 352, Euston-road, London, N.W.1. The brochure is compiled in the following sections for easy reference : Section A, "Shelters"; Section B, "Air Purification and Air-Circulating Plants"; Section C, "Windows, Doors, Shutters and Emergency Exits"; Section D, "Accessories and Equipment."

The section dealing with steel shelters shows drawings and photographs of the firm's standard shelter constructions which have been designed to comply with the loading recommended by the Home Office. The principal shelter illustrated is the arch steel type, suitable for first-aid posts, control rooms, cleansing stations, etc. The framework is of mild steel joists covered with dovetail steel sheets which are concreted on the outside to a minimum thickness of about 6 in. The standard units are 10 ft. long, but the overall length of the shelter and the lay-out of the internal arrangement can be varied to suit requirements.

Also illustrated and described are the "Tunnel" and "Family" types of shelter.

THE COVERING OF WAR RISKS.

The decision of insurance companies to exclude war risks on renewal of all policies and in all future insurances, coupled with the Government's intimation that they can offer no insurance to property owners in the event of damage caused by air raids and for war risks of any description, has resulted in the formation by the Property Owners' Protection Association, Ltd., of the Property Owners' War Risks Mutual Society, Ltd. Full particulars may be obtained from the Secretary, Spencer House, South-place, E.C.2.



THE FRASER AND ELLIS GASPROOF MANHOLE COVER. (SEE THIS PAGE.)

A DUAL PURPOSE MANHOLE COVER.

A dual purpose manhole cover and frame for the emergency exits of A.R.P. trenches and dug-outs has been designed by Messrs. Fraser and Ellis, Ltd., Carlyle Works, Old Church-street, Chelsea. The cover is so designed as to make it available for use as a ventilating cover during peace time and capable of conversion into a sealed gas-tight cover in a few moments. The cover can be securely bolted down to the exit shaft, and when locked can only be opened from ground level with a key. By the introduction of a lever-arm which can be operated from the floor of the trench, the task of opening the cover from the top of the ladder leading to the emergency exit is very much simplified. An illustration is on this page.

A.R.P. IN INDUSTRIAL FIRMS.

A short while ago Messrs. E. K. Cole, Ltd., Ekco Works, Southend-on-Sea, Essex, offered to place their experience of A.R.P. work, gained in the provision of shelters for 3,000 employees, at the free disposal of other industrialists contemplating similar activities—the object being to assist in minimising the unnecessary duplication of time, money and labour.

The response to the offer has been such that whilst the firm is still willing to give every co-operation to individual manufacturers, it has been considered that a more general method of disseminating information was necessary and there has been prepared a series of three articles : (1) "A.R.P. Shelter Lighting"; (2) "A.R.P. Shelter Construction"; and (3) "Staff A.R.P. Organisation and Training."

These articles are available to industrialists who contemplate A.R.P. schemes at their works and who are in search of information and guidance on the subject.

SHELTERS FOR 10,000 WORKERS

With its first A.R.P. plan—one of the biggest in the country—virtually complete, and deep air raid shelters provided for some 5,000 workers, the Austin Motor Company is just embarking on its second scheme to provide deep shelters giving complete immunity for well over 10,000 more of its employees at a further cost of £25,000.

The new scheme is no less than a huge subterranean tunnel system, excavated out of sandstone rock, under the company's test track and flying ground adjacent to the 100-acre Longbridge Works, and will replace extensive surface trench systems contemplated in the first plan. The tunnels, which are being driven under the Austin test track at four different points at the rate of 40 feet per day, will all conform to a standard semi-circular design with a floor width of 16 ft. 9 in. and a height of 9 ft., being reinforced with steel arches and steel sheeting. Their average depth will be 55 ft. below the surface and with access through the gently inclined adits it will be possible for full occupation to be effected in a few minutes after receiving an air-raid warning.

The tunnels will have an aggregate length of 1,000 yards, and will provide seating accommodation for half the number of occupants. A very efficient system of ventilation will be provided through air inlets situated 18 feet above very high ground, which, it is anticipated, will be clear of any surface concentrations of gas, so that the entrance and exit adits can be provided with air locks.

Drinking water supplies, rest and first-aid rooms, lavatories and all essential amenities are included in the scheme, which will also combine auxiliary generating sets in case of failure of mains current supplies, and loud-speaker equipment throughout the system for broadcasting instructions, music, and news items to those taking shelter.

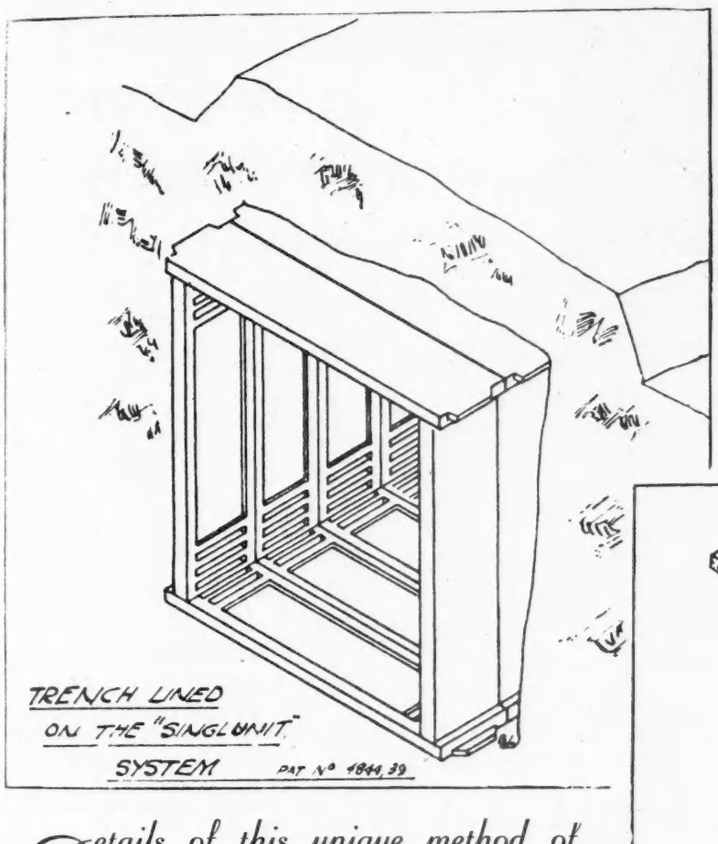
Deliveries of the steel linings and reinforcements being guaranteed, and with the excavating work, which involves the removal of 18,000 tons of sandstone, proceeding night and day, it is estimated that these tunnels will be complete and fully equipped within ten weeks' time.

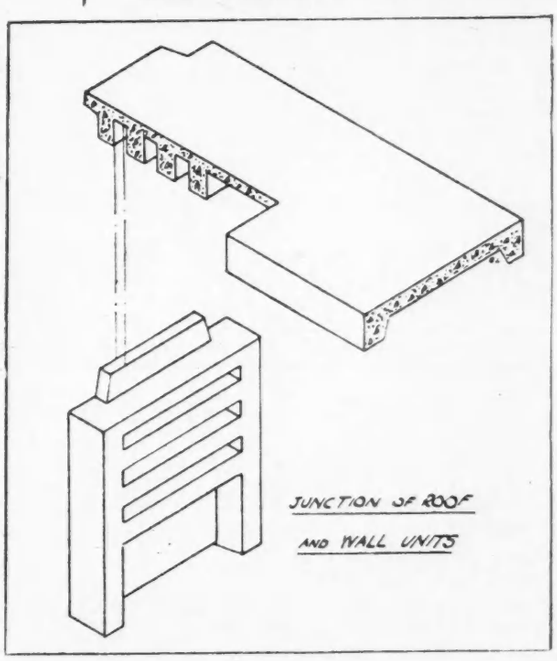
"SINGLUNIT" TRENCH LINING AND SHELTERS

Approved by Home Office.

UNITS ADAPTABLE FOR WALLS, ROOF & FLOOR

VARIATION OF FIVE DIFFERENT WIDTHS



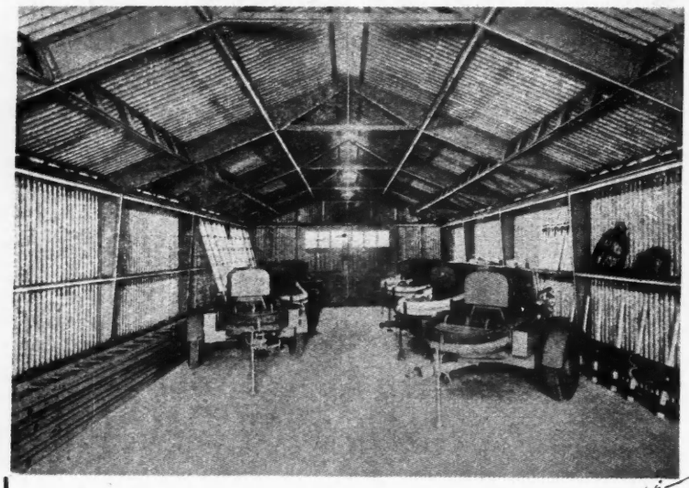


Details of this unique method of lining Air Raid Trenches with reinforced pre-cast concrete units are given in the Editorial pages of this supplement.

FURTHER PARTICULARS FROM:

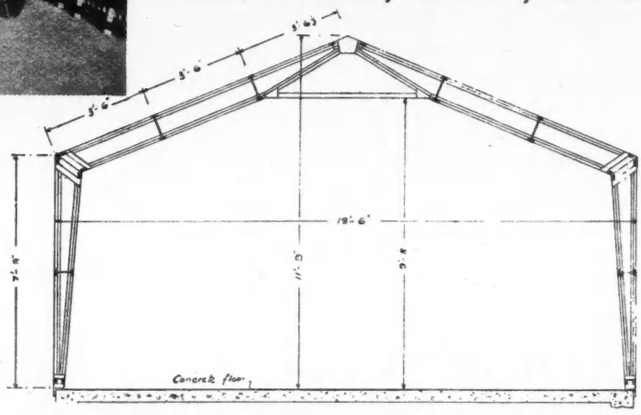
ALEXANDRA STONE Co. Ltd. VERNON HOUSE, SICILIAN AVENUE, W.C.1	WEST MIDLANDS, BERKS, BUCKS, S. ESSEX, HERTFORD, BEDFORD, N.E. MIDDLESEX & N.E. METRO. BOROUGHS.
BRISTOL STONE & CONCRETE CO. 9B, WHITELADIES ROAD, BRISTOL, 8.	SOMERSET, WILTSHIRE & GLOUCESTER.
CROFT GRANITE BRICK & CONCRETE CO. CROFT, NEAR LEICESTER.	LEICESTER, S. NOTTS, S. DERBY, NORTHANTS, RUTLAND & EAST WARWICKSHIRE.
SHARP, JONES & CO. LTD. PARKSTONE, DORSET.	HANTS, DORSET, N. ESSEX, SUFFOLK, CAMBRIDGE, W. MIDDLESEX & W. MET. BOROUGHS.
SPUN CONCRETE LTD. RYE HARBOUR, SUSSEX.	KENT, SUSSEX, SURREY, S. MIDDLESEX & S. MET. BOROUGHS.

PORTABLE LIGHT METAL STRUCTURES



for CAMPS, DORMITORIES, FIRE STATIONS, CASUALTY WARDS, ADMINISTRATIVE OFFICES, ETC., ETC.

Temporary Fire Station recently erected in Worthing for the Worthing Corporation, consisting of 8 bays of light section Steel Arches weighing approx. 175 lbs. each.



Full particulars from
PATENTEES:

Units are rapidly erected and easily transported and stored.

LIGHT STEEL SECTIONAL CONSTRUCTIONS LTD., 170, TARRING ROAD, WORTHING.
Manufacturing Licence granted to ACCLES & POLLOCK LTD., OLDBURY, BIRMINGHAM. Telephone: Worthing 387.

TRENCH LINERS
in precast Concrete.

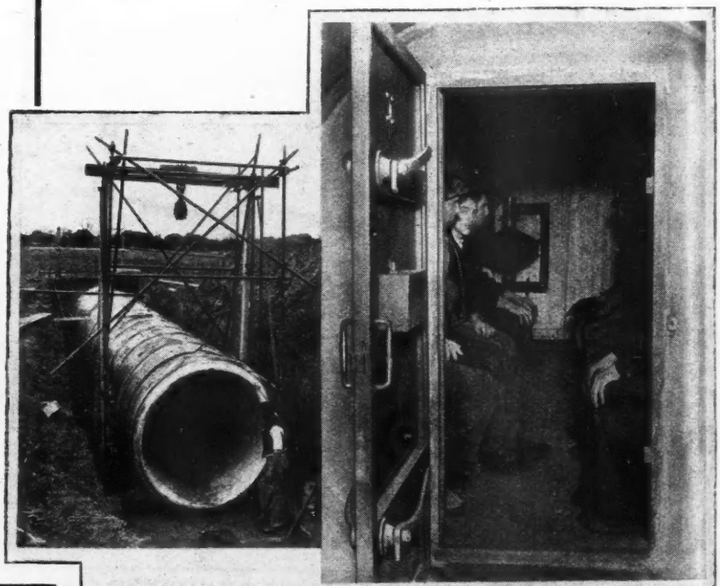
TUBULAR SHELTERS
complete with Doors, Seating, Air Lock, etc.

SECTIONAL GARDEN SHELTERS
for erection by Householder.

Schemes have been prepared for precast trench lining units, and prices and designs can be submitted without delay.

The Ellis Precast Concrete Tubular Shelter is constructed of 72" diameter pipes cast on the centrifugal plus concussion process, and is equipped complete with Gasproof Doors, Air Lock, Flooring, Seating, Lavatory accommodation; Escape Manhole; Ladder and Manhole cover.

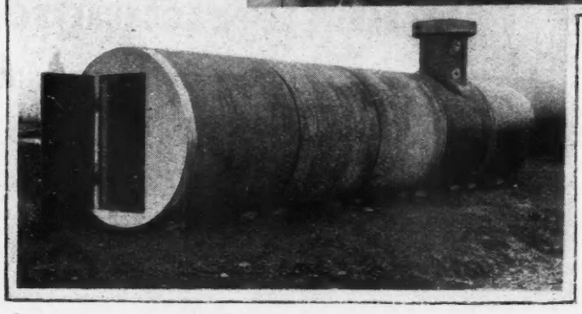
The Sectional Garden Shelter is made in four segments for ease in handling, and is so constructed that it can be erected without difficulty by unskilled labour.



JOHN ELLIS & SONS, LTD.
LEICESTER

Head Office: WELFORD HOUSE, WELFORD PLACE, LEICESTER. Phone: Leicester 5682 (5 lines.)
London Office: CAXTON HOUSE, TOTHILL STREET, S.W.1. Phone: Whitehall 8911 (2 lines.)

Ellis OF LEICESTER



THE LONDON FERRO-CONCRETE CO. LTD.

FOR THE DESIGN AND CONSTRUCTION OF ALL CLASSES OF A.R.P. WORK

Strutting and protection of existing buildings and basements.

Trenches and First-Aid posts.

Adaptation and construction in existing factories to suit factory conditions and with minimum inconvenience to business.

Deep Communal Shelters, new Basements and Strong Rooms.

Whenever possible we arrange the planning so that the A.R.P. work can be used for normal business purposes.

We design and carry out the whole of the work and will be pleased to prepare schemes and submit prices.

Enquiries will receive immediate attention, and we can undertake any of these works at the shortest notice.

Advice given on A.R.P. in new buildings.

THE LONDON FERRO-CONCRETE CO. LTD.

9 TUFTON STREET, WESTMINSTER, S.W.1

Telephone: ABBEY 5582 Telegrams: Reinforced, Sowest, London

STRENGTHENING OF BASEMENTS

HIGGS & HILL, LTD.,

Contractors for the strengthening of Basements in important Government buildings, offer their experience to Local Government bodies and Business Houses.

CROWN WORKS, SOUTH LAMBETH ROAD, S.W.8

For Decontamination Stations

A.R.P. HANDBOOK No. 1 states:—

Very few materials comply with this recommendation and at the same time are proof against acids, gases, and the like used in modern chemical warfare. Bombs containing Hydrocyanic, Chlorine, Lewisite, Mustard and Phosgene, either in the form of gas or liquid, may be experienced, and all these chemicals readily attack building materials containing lime, especially cements and plaster, which rapidly disintegrate in their presence.

Exhaustive chemical and physical tests demonstrate that Penrhyn Slate adequately suits the required conditions and affords the most economical method of providing the necessary protection and at the same time giving structural stability. These qualities are due to Penrhyn Slate being non-absorbent and almost completely free from calcium in the form of lime in chemical composition.

"As far as possible walls, particularly the lower 6 feet, should be finished with smooth-faced impervious material which can be washed and decontaminated."

During the past few months we have had occasion to study at some length the use of slate for decontamination stations, and we are now engaged in supplying materials for centres which are being erected in various parts of the country.

Estimates for the necessary slabs cut to any specification will be rendered promptly on receipt of your enquiry.

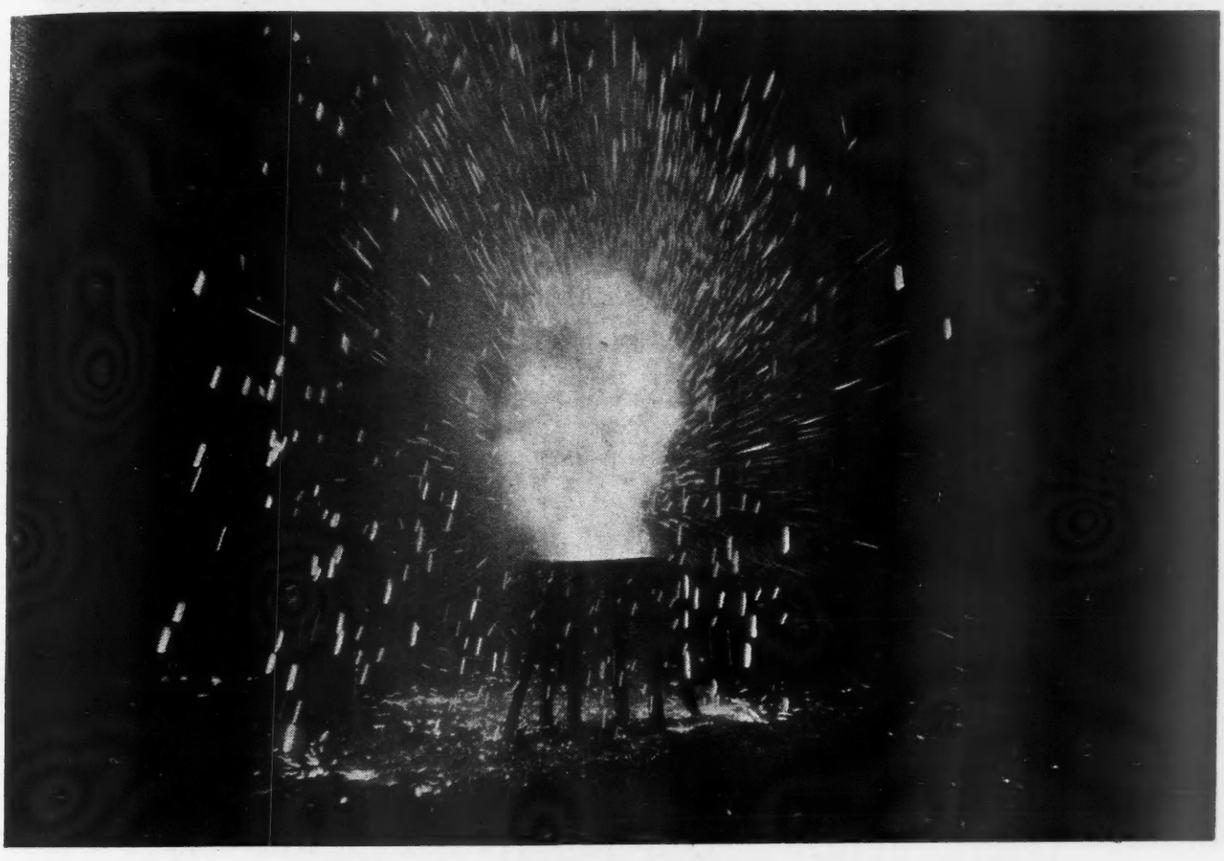
JOHN FLETCHER & DIXONS LTD.,

SLATE WORKS, CAERNARVON, N. WALES. CAERNARVON 52.

LONDON OFFICE & ENQUIRIES:

MASTIC & SLATE COMPOUNDS LTD.,

152, Abbey House, Victoria Street, LONDON, S.W.1. Abbey 4129.



Kimoloboard IS FIREPROOF!

We agree that 'Fireproof' is a relative term and our tests only go up to the temperature (about 5,400°F.) generated by Thermite. The photograph shows contents of a 1 kilo incendiary bomb ignited on a ½" thick sheet of KIMOLOBOARD. Result—no penetration, no cracking, only slight surface impingement and paper label on back of sheet unscorched! The still red-hot upper surface was sprayed with cold water—again no cracking. That is what we mean by 'Fireproof.' Succeeding announcements will show how this remarkable fireproof property in an easily worked panelling board can be applied to practical advantage. Meanwhile, may we please send you detailed literature?

CELLACTITE & BRITISH URALITE LTD., Lincoln House, 296/302, High Holborn, London, W.C.1.

'Phone: Holborn 5291-2 and 8824.

'Grams: Cellactite, Holb, London.
Works: Higham, Kent.

A REALLY FIREPROOF COMPOUND OF ASBESTOS AND DIATOMACEOUS EARTH

Tas/Kim 214

REINFORCED CONCRETE FOR A·R·P

We undertake the design of all classes of structures in connection with A.R.P.

INDENTED BAR &

CONCRETE ENGINEERING CO., LTD.

VINCENT HOUSE, VINCENT SQUARE, WESTMINSTER, S.W.1.

Telegrams: "PATINBAR, SOWEST, LONDON." Telephone: Victoria 1642 (3 lines).

"THE BUILDER" GUIDE TO MATERIALS AND EQUIPMENT FOR A.R.P.

ACCESS LADDERS.
DREW, Clark & Co.
J. B. GRAVITY Ladder Co., Ltd.

AIR CONDITIONING.
AIR CONDITIONING CORPN. (JEFFREYS), LTD.
CARRIER Engineering Co., Ltd.

AIR FILTRATION UNITS.
BRABY, Fredk., & Co., Ltd.
CARRIER Engineering Co., Ltd.

ASPHALTE.
"ANTIGASPHALT." LIMMER & TRINIDAD LAKE ASPHALTE CO., LTD.
EXCEL ASPHALTE CO., LTD.
FIELD & Palmer, Ltd.
PERMANITE, Ltd.

BARS, STEEL REINFORCING, FOR CONCRETE BOMB-PROOF SHELTERS.
MESH Steel.
ROM River Co., Ltd.
"TWISTEEL" Reinforcement, Ltd.

BASEMENT (STRENGTHENING OF).
ACROW (Engineers), Ltd.
BOULTON Tubular Structures, Ltd.
HIGGS & Hill, Ltd.
LONDON Ferro-Concrete Co., Ltd.
STEEL Scaffolding Co., Ltd.

BINS (DECONTAMINATION).
AIR CONDITIONING CORPN. (JEFFREYS), LTD.
BRABY, Fredk., & Co., Ltd.
BUTTERFIELD'S of Shipley.

CAMOUFLAGING.
FREEMAN, JOS., SONS & CO., LTD.
NICHOLLS & Clarke, Ltd.
SILICATE PAINT CO.
STEEL Scaffolding Co., Ltd.

CHECK ACTION FLOOR SPRING HINGES (FOR GAS-PROOF DOORS).
ADAMS, ROBERT
NICHOLLS & Clarke, Ltd.

CHEMICAL CLOSETS.
ELSAN CO.
NICHOLLS & Clarke, Ltd.

CONCRETE.
BRADFORD, F., & CO., LTD.
GIRLING'S FERRO-CONCRETE CO., LTD.
LAFARGE ALUMINOUS CEMENT CO., LTD.
TRENT Concrete, Ltd.

CONCRETE HARDENER.
CEMENTONE NO. 8. JOS. FREEMAN, SONS & CO., LTD.

CONCRETE SHELTERS.
ALEXANDRA Stone Co.
ATTOC BLOCKS, LTD.
BRISTOL Stone & Concrete Co.
CROFT Granite Brick & Concrete Co.
ELLIS, JOHN, & SONS, LTD.
GIRLING'S FERRO-CONCRETE CO., LTD.
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SELF-SENTERING EXPANDED METAL CO., LTD.
SHARP Jones & Co., Ltd.
SPUN Concrete Ltd.
STENT Precast Concrete, Ltd.
TRENT Concrete, Ltd.
TRIANCO, LTD.
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WALLIS, G. E., & SONS, LTD.
WATES, Ltd.
WRIGHT, SAMUEL, & CO., LTD.

CONCRETE STRONG ROOMS.
MILNERS' Safe Co., Ltd.

CUBICLES (LAVATORY).
FLEXO Plywood Industries, Ltd.

DAMP PROOFING.
ADAMITE Co., Ltd. "Colemanoid."
BRITISH Bitumen Emulsions, Ltd.
BYRD, A. A., & CO., LTD.
EXCEL ASPHALTE CO., LTD.

DAMP PROOFING—*(continued).*
FIELD & Palmer, Ltd.
FREEMAN, JOS., SONS & CO., LTD.
GRANGERSOL, Ltd.
JONES, Jno., (Steel-Crete), Ltd.
KERNER-Greenwood & Co., Ltd., "Pudlo."
NEWTONITE, LTD.
NICHOLLS & Clarke, Ltd.
PERMANITE, Ltd.
R.I.W. Protective Products Co., Ltd.
RIGBY (London), Ltd.
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SANDELL, JOS., & CO., LTD.

EXTENSION LADDERS
DREW, CLARK & CO.

FAN UNITS (FOR WALL PARTITIONS, SHELTERS).
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FIREPROOF FLOORS.
ATTOC BLOCKS, LTD.
KING, J. A., & Co., Ltd.
SMITH'S FIREPROOF FLOORS, LTD.
UNEEK CONSTRUCTIONS, LTD.

FIREPROOFING MATERIALS.
CASEBOURNE & CO. (1926), LTD.
CELLACTITE & BRITISH URALITE, LTD.
IMPERIAL Chemical Industries, Ltd.

FOR CONTINUATION OF THIS GUIDE, SEE PAGE xlii.

SURE PROTECTION WITH THE FRASER & ELLIS LTD.

DUAL PURPOSE VENTILATION MANHOLE COVER

PATENT APPLIED FOR NO. 3674/39.

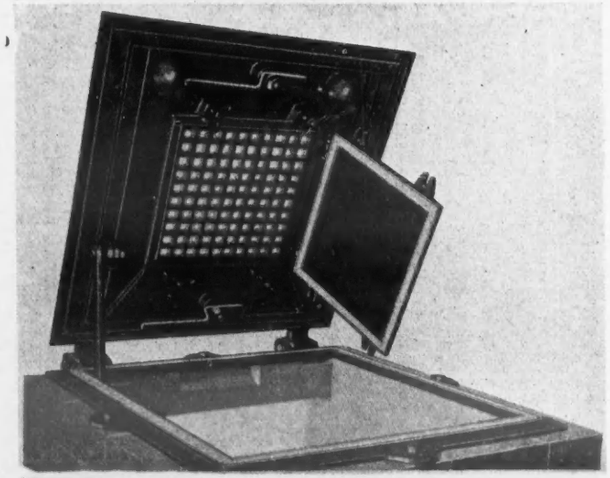
The Fraser & Ellis Dual Purpose cover has three main advantages over the loose type of grating suggested by the Home Office.

Above—Cover in closed position.

Size 24" x 24" clear opening. Approximate weight 1 cwt. 2 qrs.

When ordering please give depth of shaft from ground level to roof of trench.

Below—Cover open showing secondary cover open to form Ventilating Cover.



● The cover is dual purpose, being available for use as a ventilating cover during peace time and capable of conversion into a sealed gas tight cover in a few moments. It would obviously be very difficult to obtain adequate supplies of sealed covers in time of emergency, and it is advisable, for a slight increase in cost, to be prepared against any contingency. This surely is the whole object of Air Raid Precautions.

● The cover is securely bolted down to the exit shaft and when locked can only be opened from ground level with a key. This obviates any possibility of children lifting the covers and falling into the trenches.

● If an ordinary type of manhole cover is used in time of emergency, it will be very difficult for civilians, using the shelters, to open the cover from the top of the ladder leading to the emergency exit. This difficulty is overcome in the Fraser & Ellis Manhole Cover by the introduction of a lever arm which can be operated from the floor of the trench. The effort required is well within the capabilities of the average person.

All Covers and Frames are cast iron and treated with Dr. Angus Smith's Solution.

Covers and Frames are supplied complete as shown except for Rag Bolts.

Price 57/6 each

free delivery within 30 miles radius of LONDON
Keys for opening from ground level 3/- each

Special Quotations for large quantities or for deliveries outside above area.

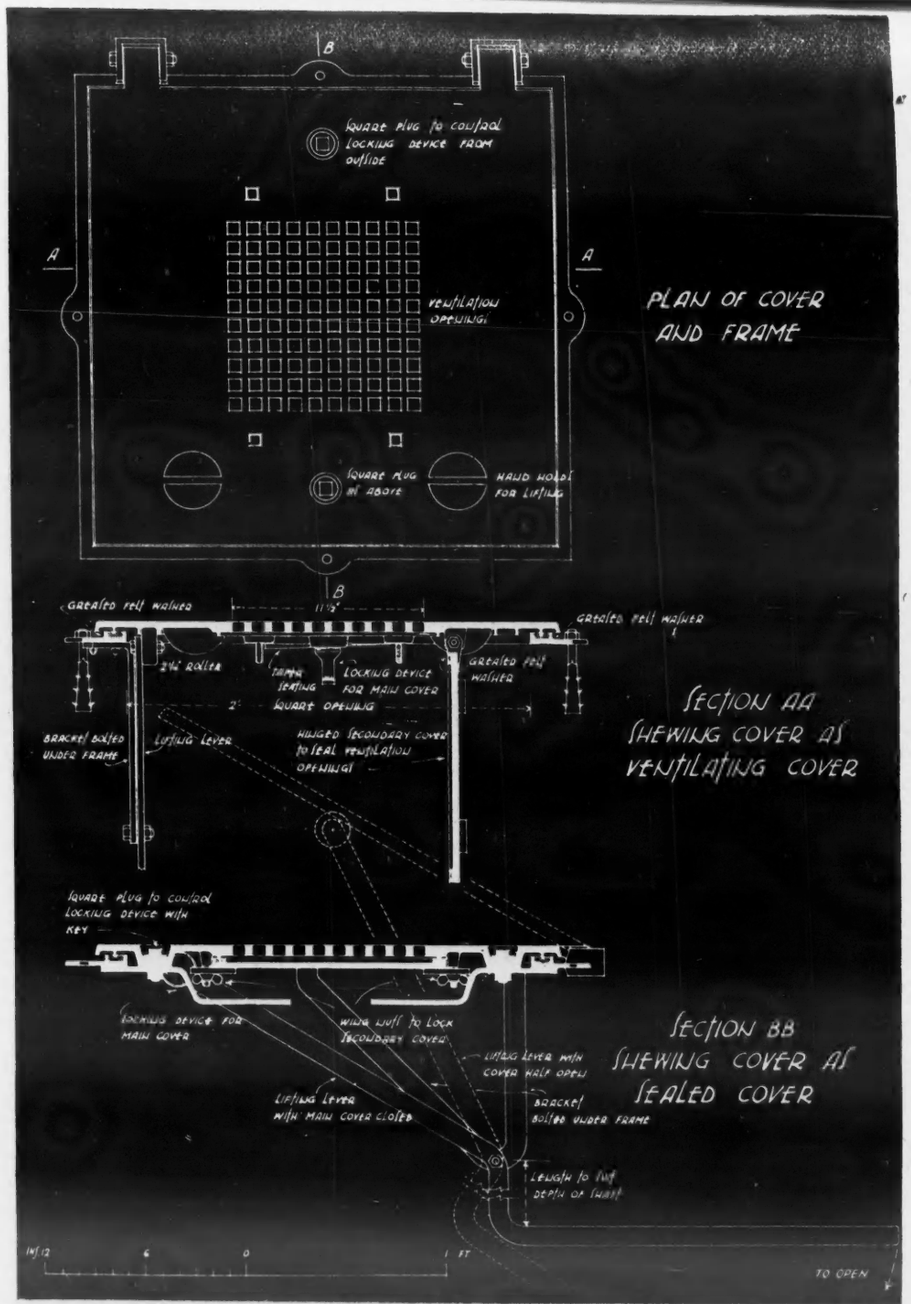
Enquiries and orders to :

FRASER & ELLIS LTD.

CARLYLE WORKS,
10 OLD CHURCH ST., CHELSEA,
LONDON, S.W.3.

Telephone : **FLAxman 8427 (3 lines)**

Telegrams : **" Retube, Southkens, London "**



"THE BUILDER" GUIDE TO MATERIALS AND EQUIPMENT FOR A.R.P. —(continued)

FIREPROOF PARTITIONS.
KING, J. A., & Co., Ld.
SANKEY-Sheldon.

FIRE-RESISTANT FINISH A R P GRADE.
NICHOLLS & Clarke, Ltd.
"PIONEER" CASEBOURNE & CO. (1926), LTD.

FIRE-RESISTING CONSTRUCTIONS & MATERIALS.
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HAYWARDS, LTD.

FIRE-RESISTING PAINTS.
FREEMAN, JOS., SONS & CO., LTD.
GRIFFITHS Bros. & Co. (London), Ltd.
NICHOLLS & Clarke, Ltd.

FLAME-PROOFING SOLUTION.
FREEMAN, JOS., SONS & CO., LTD.
NICHOLLS & Clarke, Ltd.

FLOORS (REINFORCED CONCRETE).
ATTOC BLOCKS, LTD.
BRADFORD, F., & CO., LTD
SMITH'S FIREPROOF FLOORS, LTD.
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GALVANISED CORRUGATED SHEETS.
BRABY, Fredk., & Co., Ltd.
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GAS FILTRATION CELLS.
AIR CONDITIONING CORPN. (JEFFREYS), LTD.

GAS FILTRATION & VENTILATION.
AIR CONDITIONING CORPN. (JEFFREYS), LTD.
BRABY, Fredk., & Co., Ltd.
CARRIER Engineering Co., Ltd.
GREENWOOD-AIRVAC: Greenwood's Ventilating Co., Ltd.
KEITH-BLACKMAN, Ltd.
LAMSON Engineering Co., Ltd.
REEVE, J. E., & SON, LTD.
STURTEVANT Engineering Co., Ltd.

GAS MASK CONTAINERS.
BRABY, Fredk., & Co., Ltd.
GREENWOOD-AIRVAC: Greenwood's Ventilating Co., Ltd.

GAS MASK STORAGE.
BOOTH, J., & SONS (BOLTON), LTD.

GAS-PROOF EXTRACTORS.
GREENWOOD-AIRVAC: Greenwood's Ventilating Co., Ltd.

GAS-PROOFING MATERIALS.
DUNLOP Rubber Co., Ltd.
LIMMER & Trinidad Lake Asphalte Co., Ltd.
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PROPERTY Owners' War Risks Mutual Society, Ltd.

KEY MEN'S ARMOURED REFUGES.
BOOTH, John, & Sons (Bolton), Ltd.
CONSTRUCTORS, Ltd.
DREADNOUGHT Fireproof Doors (1930), Ltd.
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LADDERS.
DREW, CLARK & CO.

LIFTING TACKLE.
TANGYES, Ltd.

LIGHTING SYSTEMS (PETROL DRIVEN).
AIR CONDITIONING CORPN. (JEFFREYS), LTD.
LISTER, R. A., & CO., LTD.
PETTERS, Ltd.
RUSTON & Hornsby, Ltd.

LININGS (TO AIR RAID SHELTERS).
ALEXANDRA Stone Co.
BRISTOL Stone & Concrete Co.
BROWN & Tawse, Ltd.
CROFT Granite Brick & Concrete Co.
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SHARP Jones & Co., Ltd.
SPUN Concrete Ltd.

MANHOLE COVERS & FRAMES.
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NICHOLLS & Clarke, Ltd.
SILICATE PAINT CO.

PARTITIONS (METAL FACED).
FLEXO Plywood Industries, Ltd.

PATENT REINFORCEMENT FOR SHELTERS.
AIR CONDITIONING CORPN. (JEFFREYS), LTD.
TRUSSED Concrete Steel Co., Ltd.

PLYWOOD (METAL FACED).
FLEXO Plywood Industries, Ltd.

POLE LADDERS.
DREW, CLARK & CO.

PORTABLE LIGHT METAL STRUCTURES.
LIGHT STEEL SECTIONAL CONSTRUCTIONS, LTD.

PROTECTIVE CLOTHING RACKS.
RONEO EQUIPMENT.
SANKEY-Sheldon.
SCAFFOLDING (Great Britain), Ltd.
STEEL SCAFFOLDING CO., LTD.

PROTECTIVE SHEETINGS.
BRABY, FREDK., & CO., LTD.
CELLACTITE & BRITISH URALITE, LTD.
DURASTEEL Roofs, Ltd.
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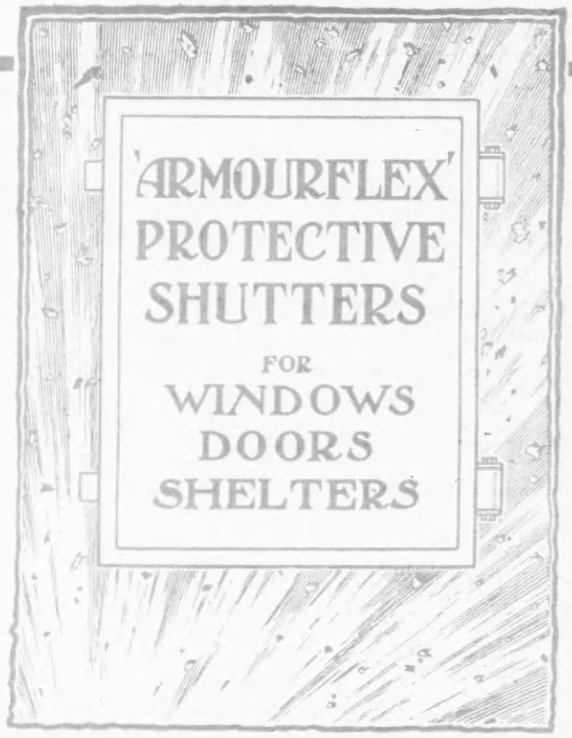
NUVAC "NOGAS" EXTRACTOR
TRADE MARK

The Nuvac Patent "Nogas" Natural Air Extractor is a ventilator which extracts vitiated air from a shelter, building or vehicle irrespective of wind direction.
Fitted with a self-aligning gas-tight valve which positively seals the aperture when closed.
Suitable for Ambulances and vehicles used for livestock and food transport.



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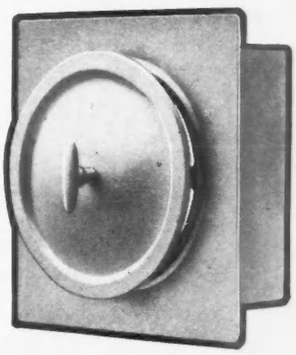


"NOGAS" WALL VENTILATOR
TRADE MARK

The "Nogas" Wall Ventilator, patent applied for, is designed to eliminate the necessity for sealing wall ventilators against gas with paper or other medium, an inconvenient process which renders ventilators inoperative for quite lengthy periods when required for general ventilation. Type W.G. 6" x 6" wall box size, is illustrated. Fitted with self-aligning valve.

GREENWOOD-AIRVAC AIR RAID SECURITY PRODUCTS FOR EVERY HOME—FOR EVERY BUSINESS—FOR EVERY SHELTER.

"NOGAS" VENTILATORS FOR LARDER, PANTRY, STORE AND KITCHEN.

GAS PROTECTION FOR ALL VENTILATED ROOMS AND OFFICES.

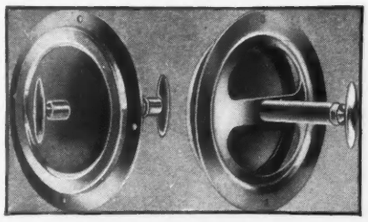
INSTANTANEOUS AND POSITIVE GAS SEAL BY A HANDLE'S TURN.

SPLINTER AND BLAST-RESISTING, FIRE AND HEAT RESISTING SHUTTERS.

DIFUSAIRE GAS-FILTRATION UNITS, MECHAVENT FAN UNITS, AND COMPLETE VENTILATION SCHEMES FOR AIR RAID SHELTERS.

"VACAIRE" PATENT EXTRACTOR, MARK 4

The "Vacaire" Patent Natural Air Extractor, Mark 4, designed exclusively for Air Raid Shelters, operates at very low air speeds of from one mile an hour upwards to hurricane force with wind blowing from any quarter. Maintains a fresh, healthy interior. No moving parts. Weatherproof.



"NOGAS" VENTILATOR
TRADE MARK

Type D.G., patent pending, is designed for a number of purposes. Used in conjunction with the "Vacaire" Extractor and Intake as described below, it ensures absolute security against gas entering a shelter via the ventilation system.
As a door ventilator it is especially suitable for keeping the atmosphere in cupboards, larders, stores, etc., sweet and fresh.

The Greenwood-Airvac Intake is designed for use with the Vacaire Extractor. It is fitted to the inlet pipe, and so constructed that fresh air is automatically deflected into the inlet pipe, thus replacing the vitiated air extracted by its component. Weatherproof.

GREENWOOD-AIRVAC REGISTERED AIR INTAKE

A unique, secure, and complete natural ventilation system for Air Raid Shelters available at a moderate cost, consisting of the "Vacaire" Extractor fitted to piping inserted near the entrance or air lock, the Greenwood-Airvac Intake being attached to piping near the opposite end. The extract and intake pipes are fitted inside the shelter with "Nogas" type D.G. Ventilators which, at a slight twist of the handle, provide instant seal against gas.

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KING CONSTRUCTIONS FOR A.R.P.

GLAZING.

Special thickened lenses for roof lights and windows. Special constructions have been developed to give high degree of protection. Approved by Home Office.

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K.3 type of centerless floor tubes which dovetail with the concrete, reinforcing rods are inserted between the tubes giving abnormal resistance to shock and sudden loads.

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Plaster slabs provide quick and easily erected partition with abnormal resistance to fire. A panel of slabs tested by B.F.P.C. for 1¼ hours to 2,250° F. Panel remained intact and fire did not pass through the partition.

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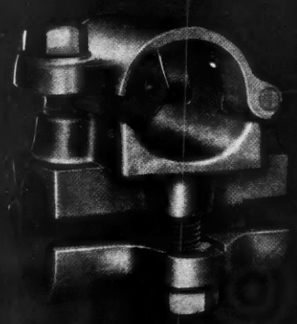
THE BUILDER
a Journal for the
ARCHITECT & CONSTRUCTOR

STRUCTURAL PRECAUTIONS

against

AIR ATTACK—4.



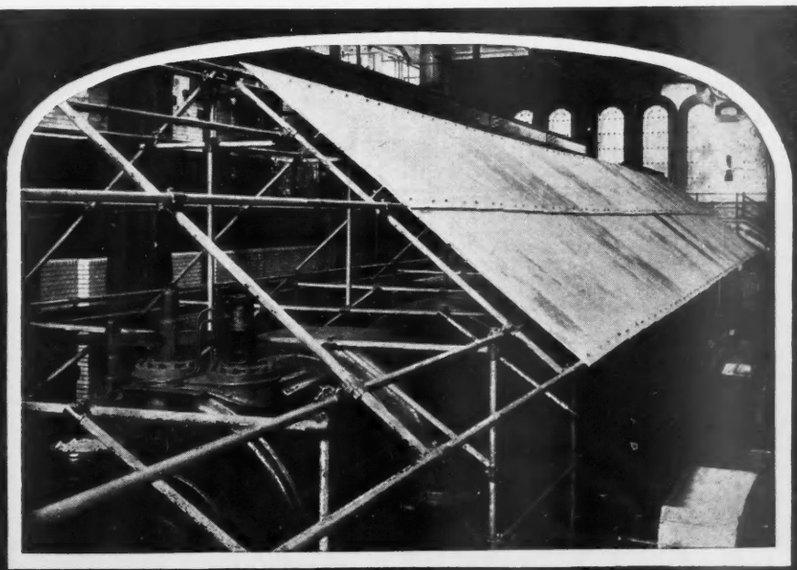


Illustration by courtesy of CITY OF LONDON ELECTRIC LIGHTING CO., LTD.

FIRE PROTECTION PANELLING SUPPORTED BY "BIG BEN" STEEL SCAFFOLDING.

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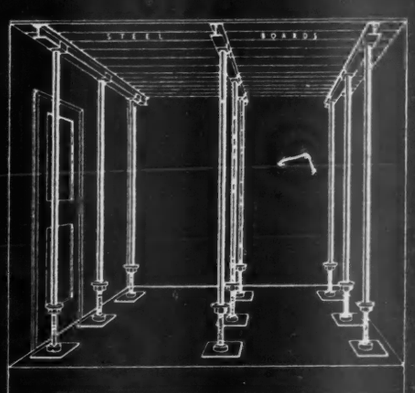
Blast Proof Shelters, Decontamination Clothing Racks, Protectional Roofs, Camouflaging, Underground Hut Reinforcement, Blast Proof Curtaining, Stretcher Racks, Key Men's Armoured Refuges, Sandbag Grilles, Safety Barriers and Handrailing.



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HAYWARDS A.R.P. STEEL DOORS

GAS, SPLINTER & BLAST PROOF

DESIGNED TO MEET ALL REQUIREMENTS

Also

GAS-TIGHT EMERGENCY COVERS FOR SHELTERS

GAS-PROOF WINDOWS

FERRO CONCRETE LIGHTS ETC.

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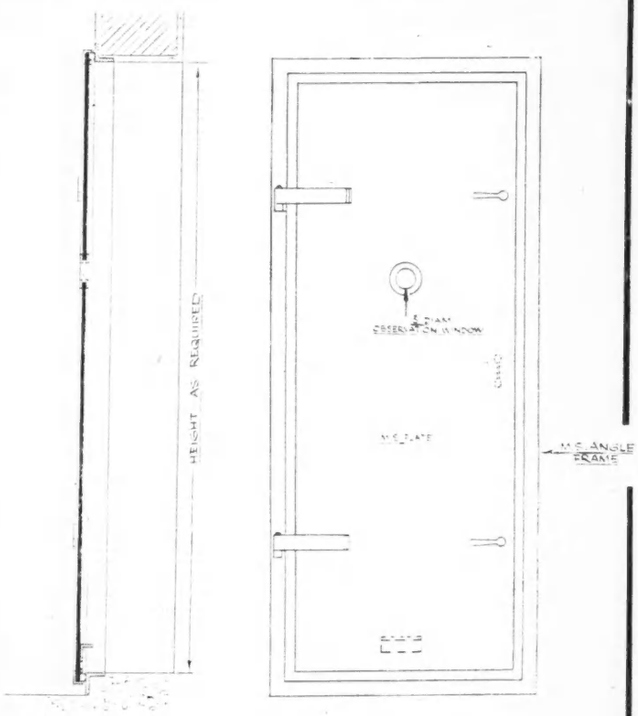
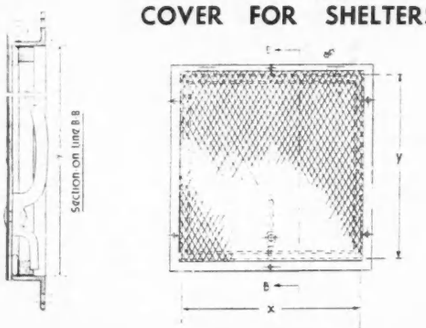


GAS-TIGHT EMERGENCY COVER FOR SHELTERS



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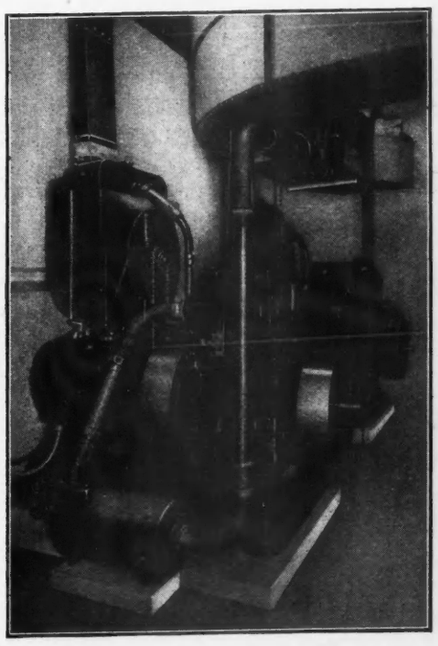

Two 14 h.p. Lister DIESEL engines coupled to 7.5 k.w., 210 volt D.C. generators installed in a London Bank.

Photo The Oil Engine

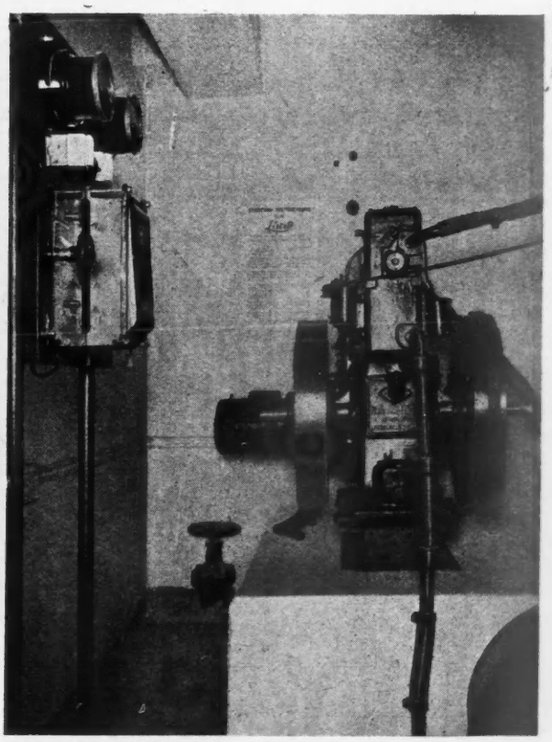

Photo The Oil Engine

The engine room of a Lister installation in a block of modern flats as seen from the opening of the gas-proof door.

SEND FOR A COPY OF OUR A.R.P. BOOKLET

Write or telephone your enquiries to:—

A.R.P. DEPARTMENT,

R. A. LISTER & CO. LTD.

IMPERIAL HOUSE,
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A

CONCRETE SHELTERS

made WATERPROOF and GASPROOF

—even against MUSTARD GAS

Sealocrete Corrugated Bitumised Tongueing British Patent.

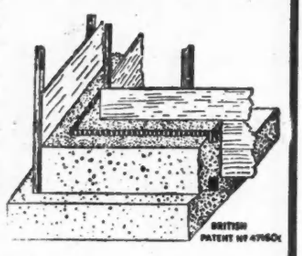

Illustration of Sealocrete Tongueing in use at the floor to wall joint and between 2 lifts of concrete.

★ Sealocrete also accelerates the construction of concrete shelters, and reduces the cost of decontamination. All interested in A.R.P. shelters should write for full particulars of this important process. Fully tested.

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Trenches and First-Aid posts.

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Deep Communal Shelters, new Basements and Strong Rooms.

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We design and carry out the whole of the work and will be pleased to prepare schemes and submit prices.

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Advice given on A.R.P. in new buildings.

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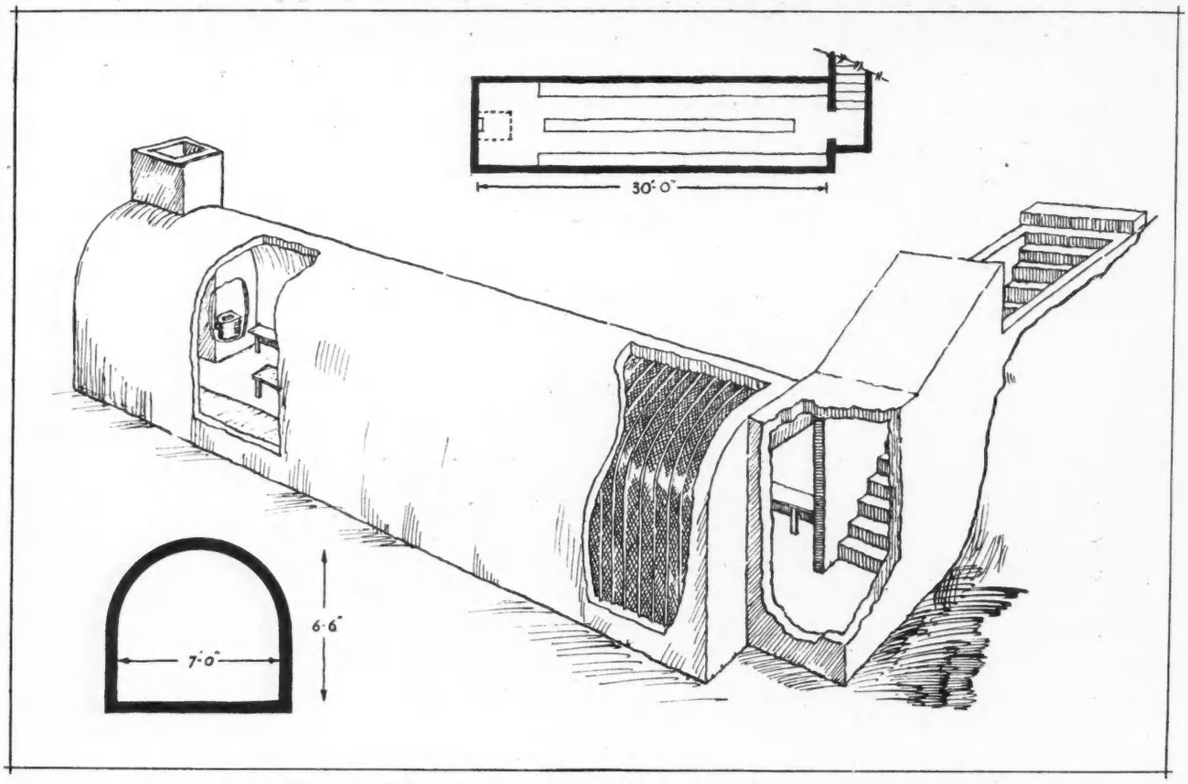

Standard Shelter, 30′ 0″ x 7′ 0″ x 6′ 6″ high, to hold 50 persons.

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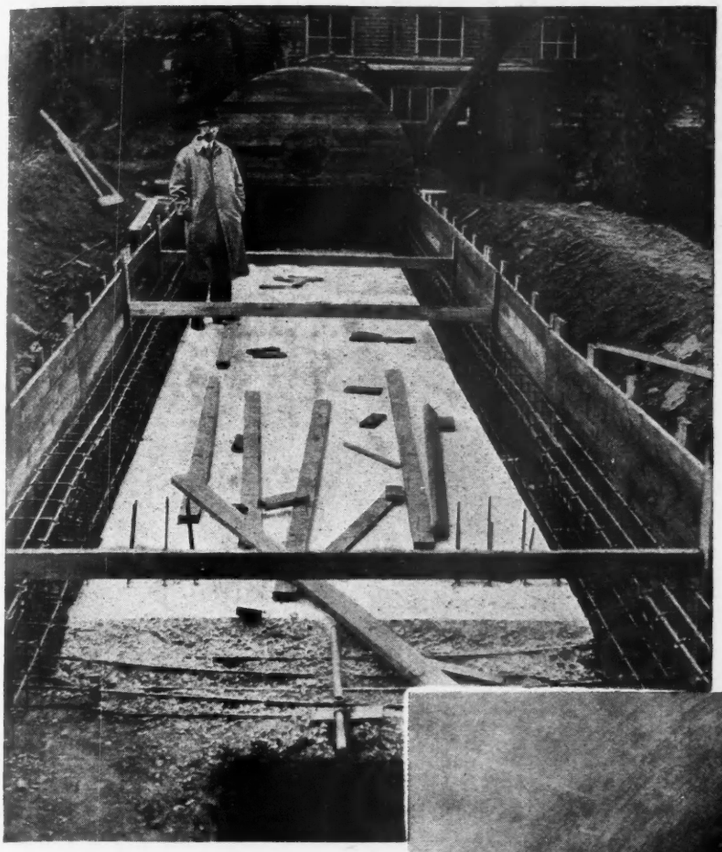


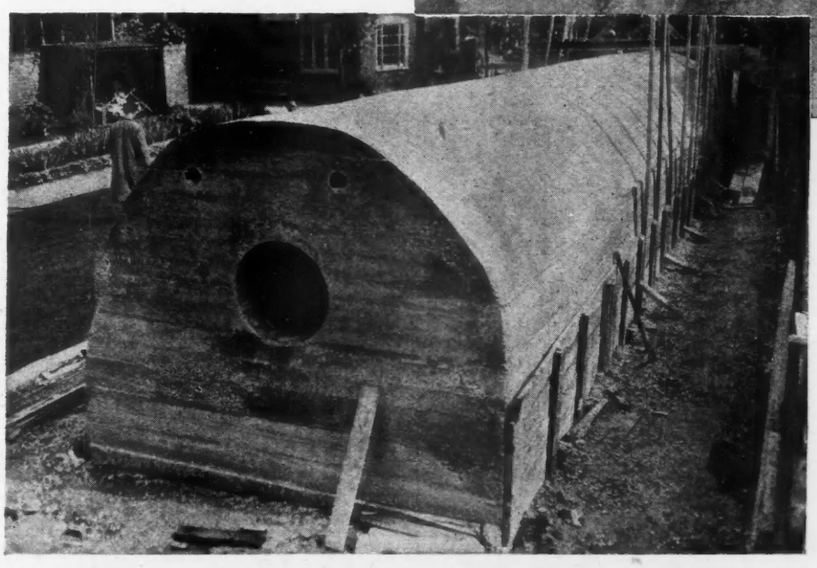
Designed by Mr. G. R. Falkiner Nuttall, A.M.Inst.C.E.

See pages xxiii and xxiv of this Supplement for illustrations and description of these Shelters.

Left :—
FOUNDATION SHOWING REINFORCED STEEL

Right :—
INTERIOR COMPLETED.

Below :—
EXTERIOR COMPLETED



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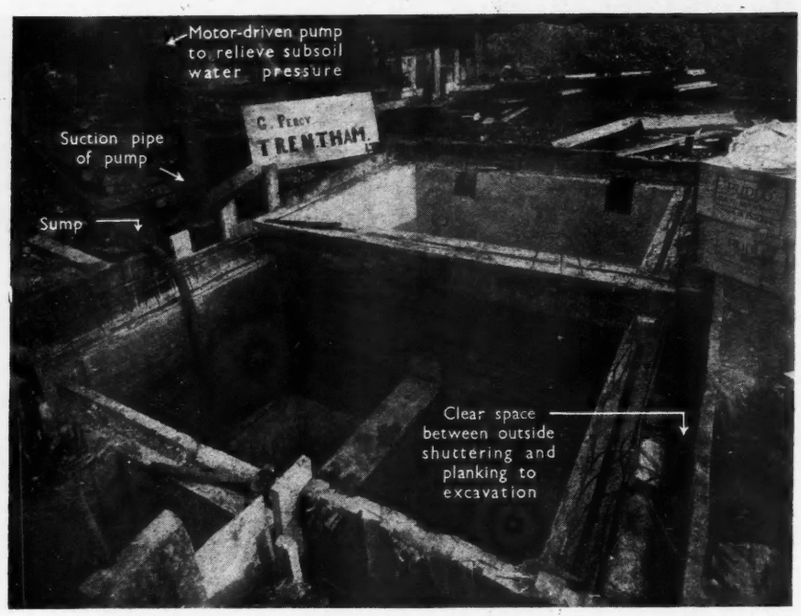
Motor-driven pump to relieve subsoil water pressure
Suction pipe of pump
Sump
G. Percy TRENTHAM, Ltd.
Clear space between outside shuttering and planking to excavation

ABOVE: THE COMPLETED CHAMBERS.

CONTRACTORS:
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THIS is a typical example of an underground chamber in flooded ground, made watertight by the inclusion, in the concrete, of 'PUDLO' Brand cement waterproofing powder. In all work of this nature—whether it be the formation of basements, machinery pits or air raid shelters—the structure should be a monolith of waterproofed concrete, of sufficient dead weight to counterbalance the upward thrust of the water it displaces; the reinforcement should be specially designed for the work it has to do, and careful attention paid to the disposition and forms of the construction joints. Ask for a copy of Specification 5A, which was worked to in this case.

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A CONSTRUCTION DETAIL.

'PUDLO'
BRAND
CEMENT WATERPROOFER

KERNER-GREENWOOD & COMPANY, LIMITED
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Sole Proprietors and Manufacturers.
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Supplement to "The Builder" May 26 1939.

THE BUILDER
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ARCHITECT & CONSTRUCTOR

STRUCTURAL PRECAUTIONS
against
AIR ATTACK—4.

Air Raid Shelters: A Digest of the Government's Requirements

General Requirements : Construction of Shelter Accommodation : Types of Shelter

By Oscar A. Bayne, A.R.I.B.A., and R. Cotterell Butler, A.R.I.B.A.

THE preparation of the Civil Defence Bill, and the issue of the draft of the provisional code of practice, together with booklets dealing with Surface Shelters and the strengthening of basements, marks a very definite stage in the development of the official A.R.P. policy.

It is now clear that throughout the length and breadth of the country (with certain limited exceptions) shelters of a light type are to be built intended only to be blast- and splinter-resisting within certain limits.

The development of this policy is not likely to decide finally the question of whether such shelters are adequate, for although the greater part of the work carried out under the Code will be under the direction of architects and engineers, the majority of them will remain disturbed in mind both professionally and personally until a more satisfactory and technically defensible solution is adopted.

The greater part of the shelter building work will be controlled precisely by the terms of the Code, owing to the influence of the financial provisions and the conditions under which the subsidy is granted; architects and engineers will, therefore, function mainly as interpreters of the Code. The very great variety of conditions which are to be found—different existing buildings—leaves a broad field for the exercise of discretion and judgment in the application of the terms of the Code. Some of these variations are outlined in the following pages.

The level of protection.

Before considering in detail the different types of shelter which have been officially adopted, it is important that the relative value of the shelters should be appreciated.

Such shelters are very commonly called "blast-proof," a description which is itself inexact and definitely misleading. As the official publications state, the shelters have been designed to:

a. Resist lateral penetration and blast *only from 500 lbs. bombs, exploding at least 50 feet away.*

b. To resist penetration from above from *only the smaller fragments from anti-aircraft shell, and from incendiary bombs of 2¼ lbs. or less.*

There is no doubt that the shelters will give this amount of protection, but there is very great doubt that such protection is adequate.

The shelters are neither blast-*proof* nor splinter-*proof*, but they do to a limited extent resist both blast and splinters, and to this extent must be regarded as a great deal better than nothing.

GENERAL REQUIREMENTS

I.—LOCATION OF SHELTERS.

Broadly speaking, shelters must be in one of the following four positions:

a. External and above ground.
b. External and below ground.
c. Inside a building and above ground level.
d. Inside a building and below ground level.

(a) Location in relation to ground level.

At the present time there is no very clear guide to the relative merits of above and below-ground shelters.

"Directions for the Erection of Domestic Surface Shelters," deals, as the title implies, only with surface shelters, and no reference is made to the value or otherwise of sinking or partially sinking the shelters. The chapter on shelters outside buildings given in the draft Code implies throughout that sunken shelters should be used.

In this chapter the statement that shelter "linings should be designed to withstand the earth pressures likely to exist on any particular site according to normal engineering principles," implies that the protective value is obtained, not from the shell or lining, but entirely from the surrounding earth.

In "Air Raid Precautions for Government Contractors," issued by the Admiralty, War Office, and Air

Ministry, in chapter III, 1 (*d*), sunken shelters are definitely favoured; it is recommended that "the floor of the shelter should be 6 ft. deep below ground wherever feasible," and reference is made to "the extreme case of a shelter erected completely above ground."

In the "Pamphlet on Shelter from Air Attack" (Home Office), it is stated that: "As a rule shelter below ground is best, as it provides protection against splinters and blast."

It will be seen that all these references are lacking in precision and that there is an almost complete absence of data on the effects of shock wave on sunken structures; nevertheless it can be regarded as definite that sunken shelters have a greater protective value than similar shelters above ground, whether they are inside buildings or in the open. In practice the choice will frequently be decided by the cost factor. The extra cost of excavation for external shelters and waterproofing where that is necessary, will be considerable. Whether equal protection could be given in an above-ground shelter for the same cost by building considerably thicker walls is a question which cannot be answered without more detailed information on the subject of the protective values of various materials.

While below-ground shelters are to be favoured wherever possible, there are a number of important factors which may affect their value and safety in individual cases. In the case of external shelters the liability to flooding must be taken into consideration in relation to local water mains, canals, rivers, reservoirs, and under ground streams.

In the case of shelters in buildings the liability to flooding must also be considered, and the proximity of boilers, supply tanks, gas hot water and steam supplies, chemical vats, heavy overhead machinery, tall chimneys, heavy or insecure overhead construction, and the degree of fire hazard, must be taken into consideration.

(b) Location of external shelters in relation to buildings.

Provided the structure of the shelter (in particular the roof) is strong enough to take the collapse of the neighbouring building, it is now regarded as an advantage to place external shelters close to the buildings they are intended to serve, because such shelters are more readily accessible. They should not, however, be placed close to very high buildings or near heavy overhead construction, water tanks, tall chimneys, or other heavy objects or pieces of construction likely to be dislcdged, and thrown down by the explosion.

Care must also be taken to ensure that the entrances and emergency exit ways are adequately protected and so placed that they are unlikely to be blocked by fallen debris. The small shelters without baffle walls referred to in "Directions for the Erection of Domestic Surface Shelters," are intended to serve small domestic buildings and are therefore to be placed facing a wall of the building, and not less than 6 ft. nor more than 15 ft. from it.

Shelters of this kind but with baffle walls opposite the entrance do not depend upon neighbouring buildings for the protection of their entrances and they may, therefore, be placed in any position.

II.—SIZE OF SHELTERS AND SPACE ALLOWANCES.

1. Small Shelters.

The recommended sizes of surface shelters for domestic purposes are as follows:—

Number of Persons.	*Size.*
6	4 ft. 6 in. by 6 ft. 6 in.
8	4 ft. 6 in. by 8 ft. 6 in.
10	4 ft. 6 in. by 10 ft. 6 in.
12	4 ft. 6 in. by 12 ft. 6 in.

Units of these sizes can be built together in double or quadruple sets. Shelters which do not accommodate more than 12 persons are required to have not less than $3\frac{3}{4}$ sq. ft. per person.

2. Larger Shelters.

The space requirements given for larger shelters for commercial buildings with only natural ventilation "by way of the normal entrances and exits" are as follows:—

Not less than 6 sq. ft. of floor area for every person in shelter.

Not less than 50 cub. ft. capacity for every person in shelter.

Not less than 35 sq. ft. of surface area of walls, floor and roof for every person in the shelter.

These figures are also given in the Code of Practice, and it is stated that the capacity of the shelter must be calculated by that rule which allows the lesser number of persons.

3. Trenches.

"For trench or tunnel shelters wholly or partly below ground level, where the width of the trench or tunnel measured inside the lining does not exceed 7 ft. 6 in., and where there are openings to the air at either end of each bay or traverse, and where not more than 50 persons are accommodated in any one bay or traverse, or where the complete shelter does not accommodate more than 12 persons, there shall be not less than $3\frac{3}{4}$ sq. ft. of floor area for every person in the shelter."

4. Ventilated Shelters.

Ventilated shelters are not dealt with in the Code of Practice.

III.—LIMITS OF CAPACITY OF SHELTERS.

Both the Code and the Memorandum on basement shelters require that "In order to minimise the number of casualties likely to result from a direct hit, shelters should preferably be limited to parties of not more than 50 persons. The distance between shelters should be not less than 25 ft. in any direction, and 40 to 50 ft. spacing is preferable where space permits."

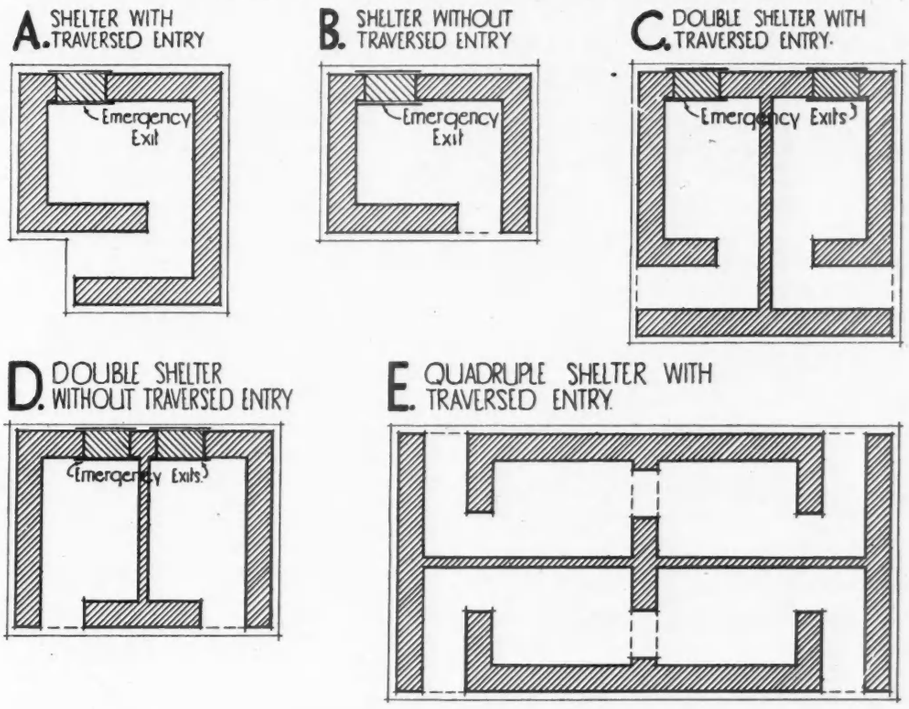
"Where, owing to restriction of the site available, it is necessary to accommodate parties of more than 50 persons, as in large basements, strong dividing walls should be provided between the parties. The maximum number in a party must be limited to 200, and the dividing walls should be provided under expert advice. As a working rule the dividing walls should be not less in thickness than twice the thickness of the floor over the shelter if made in reinforced concrete, nor less than three times the thickness of the floor over the shelter if made in brickwork or masonry. In no case may the dividing walls be less than 12 in. thick in reinforced concrete, nor less than $13\frac{1}{2}$ in. thick in brickwork or masonry."

This paragraph implies that where the site conditions are restricted, not only may the number of persons in each party be increased, but the distance between shelters may be reduced or omitted. It may, however, be regarded as better practice to reduce the space between shelters rather than increase the size of each party. For instance, in dealing with 800 people it would be better to have 16 shelters adjoining one another with 50 persons in each, than to have four shelters each containing 200 persons and separated only by spaces equivalent to the space occupied by the extra walls in the first case.

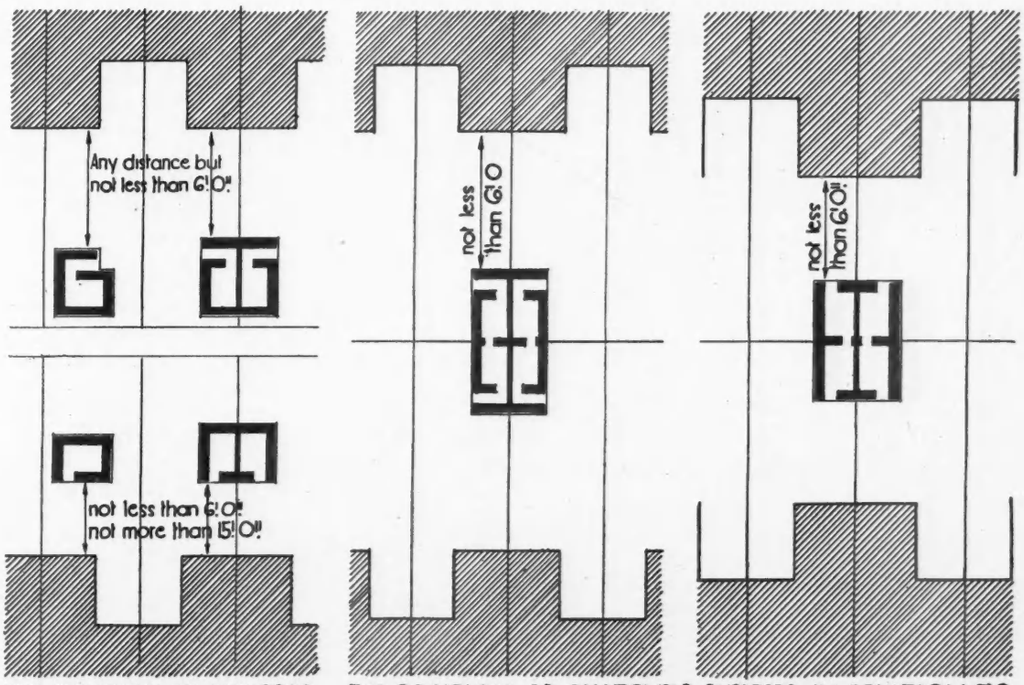
IV.—ACCESS AND ENTRANCES.

The official designs for small domestic shelters have an entrance and an emergency exit; for larger shelters the Code requires that "each shelter must have two entrances situated as far as possible from one another."

TYPES OF GOVERNMENT SURFACE SHELTER FOR DOMESTIC PURPOSES


A. SHELTER WITH TRAVERSED ENTRY
Emergency Exit
B. SHELTER WITHOUT TRAVERSED ENTRY
Emergency Exit
C. DOUBLE SHELTER WITH TRAVERSED ENTRY.
Emergency Exits
D. DOUBLE SHELTER WITHOUT TRAVERSED ENTRY
Emergency Exits
E. QUADRUPLE SHELTER WITH TRAVERSED ENTRY.

THE SITING OF SHELTERS



THE POSITION OF SHELTERS IN RELATION TO BUILDINGS

THE POSITION OF QUADRUPLE SHELTERS IN RELATION TO BUILDINGS AND PROPERTY LINES.

The rule given for the width of entrances is "1 ft. width of opening for every 50 persons occupying the shelter, with a minimum of 2 ft. 6 in."

There is, of course, a distinction between entrances and emergency exits.

If more than one entrance is provided and they are spaced widely apart, well protected against the fall of debris, and if one of them discharges outside the probable debris area, then they may be regarded as adequate for emergency exits. If, however, such well-arranged and protected entrances cannot be provided, then one, preferably more, possible means of exit should be provided for use in an emergency. Such emergency exits may take the form of :—

a. Small panels or doors in the wall opening into small tunnel-ways or large pipes leading to manholes placed outside the debris area.

b. In the case of basement shelters, panels or doors connecting with adjoining rooms or adjoining basements.

c. Small sections of wall in lime or weak mortar and marked so that the section which could be pulled down or knocked out in an emergency is readily recognisable.

V.—SANITARY ACCOMMODATION.

"Sanitary accommodation should be provided close to, and if possible within, the shelter. One closet seat should be provided for 25 persons with subsidiary buckets and urinal facilities. The closet partitions should be carried right up to the ceiling of the shelter."

CONSTRUCTION OF SHELTER ACCOMMODATION

1. LATERAL PROTECTION IN GENERAL.

The standard of lateral protection laid down for factories and commercial buildings may be provided by :—

a. Mild steel, not less than 1½ in. thick.
b. Solid brickwork or masonry not less than 13½ in. thick.
c. Reinforced concrete not less than 12 in. thick.
d. Earth, sandbags, ballast, or broken stone not less than 2 ft. 6 in. thick.

The directions for the erection of domestic surface shelters also permit walls 15 in. thick of mass concrete or concrete block.

2. OVERHEAD PROTECTION IN GENERAL.

The standard of overhead protection laid down may be provided by :—

a. Mild steel not less than ¼ in. thick.
b. Concrete not less than 6 in. thick.
c. Concrete of structural quality not less than 4 in. thick.
d. Brickwork or masonry arches, the arch ring being not less than 8½ in. thick.
e. Earth, sandbags, ballast or broken stone not less than 1 ft. 6 in. thick.

3. EXTERNAL WALLS—ABOVE GROUND.

The Code accepts as suitable "13½ in. brick walls in cement mortar, hydraulic lime mortar, or cement-lime mortar. . .;" a particular mixture is, however, specified for domestic surface shelters as follows: "The mortar used for building the brickwork or concrete block masonry shall be composed of one part of Portland cement, one-tenth part lime putty or hydrated lime, and three parts of approved clean sand by volume."

This mixture may be taken as a standard mortar for all new work.

The Code also allows reinforced concrete walls 12 in. thick of concrete of structural quality containing not less than 112 lb. of cement to 2½ cub. ft. of coarse aggregate.

The concrete block or mass concrete walls 15 in. thick permitted for small domestic shelters are required to be composed of 112 lb. of Portland cement to 2½ to 3¼ cub. ft. of approved clean sand and 5 cub. ft. of approved clean hard aggregate, the grading of which is specified.

4. EXTERNAL WALLS—BELOW GROUND.

It having been laid down that the protection required in a basement or sunken shelter is to be derived from the surrounding earth, the type of wall required below ground is not defined. It can therefore be assumed that any existing basement or cellar wall in good condition is adequate and need not be strengthened.

Now walls for sunken shelters need, therefore, be only of the thickness required for retaining wall purposes —which must depend upon the depth of the wall, the nature of the surrounding earth and the water level. In most normal work 13½ in. brick or 9 in. brick with buttressing piers, if necessary, will be adequate, or concrete walls either mass or reinforced and of the usual thickness.

5. SHELTER ROOFS—EXTERNAL.

The standard roof slab laid down for use over Domestic Surface Shelters is specified as follows :—

"The roof shall consist of reinforced concrete 5 in. thick. It may be cast *in situ* or composed of precast reinforced sections of convenient size with rebated joints.

"The reinforcement shall consist of ⅜ in. mild steel rods spaced at 5½ in. centres on the shorter span, and, in addition, in the case of the roof cast *in situ*, at 11 in. centres on the longer span. An alternative reinforcement, consisting of a steel mesh of equivalent value, will be equally satisfactory.

"The reinforcement shall be placed 1 in. from the internal face of the roof."

If, however, such shelters are placed close to buildings of more than one storey, it is reasonable to assume that the roofs should be of greater strength owing to the danger of debris falling upon them. If the shelters are liable to receive falling debris, the roofs might be designed in accordance with the loadings laid down for shelters located inside buildings, as quoted below.

6. SHELTER ROOFS—INTERNAL.

The Code requires that the roofs of shelters located inside buildings should be capable of carrying the following superimposed loads in addition to the normal superimposed and dead loads which the floor or roof would be designed to carry for normal purposes. For buildings in which loads are carried on load-bearing brickwork or masonry :—

For two floors above	200 lb. per sq. ft.
For four floors above	300 lb. per sq. ft.
For more than four floors ...	400 lb. per sq. ft.

For buildings in which loads are carried on steel or reinforced concrete frames :—

200 lb. per sq. ft. irrespective of the number of floors above.

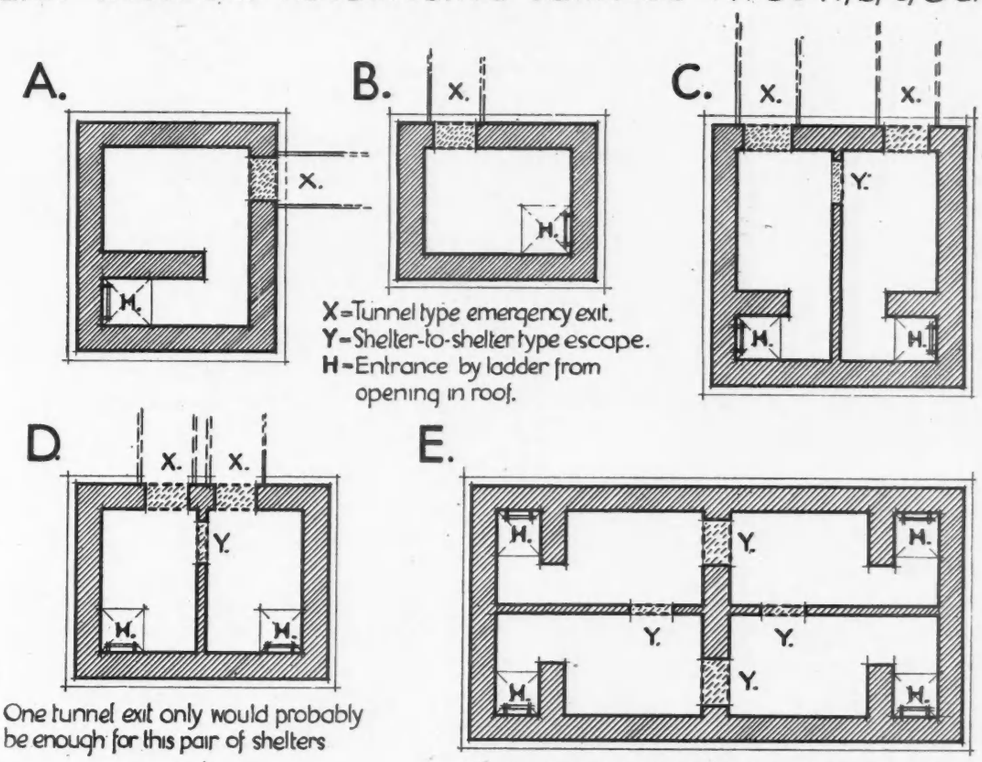
TYPES OF SHELTER

I.—TRENCHES AND TRENCH SYSTEMS.

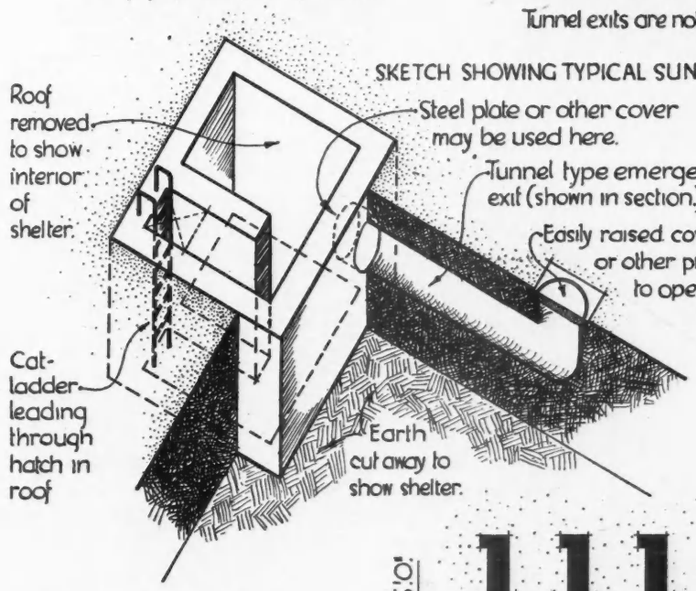
The Code lays it down that trench linings should be strong enough to serve as normal retaining walls, but need not be stronger. It also states that "suitable provision should be made for drainage and removal of water percolating from the ground, and drainage should be so arranged that surface water does not run into the trenches."

This suggests that it would be advisable to grade the floor of all trenches and sunken shelters to a small sump

SUNK SHELTERS RESEMBLING SURFACE TYPES A, B, C, D and E.

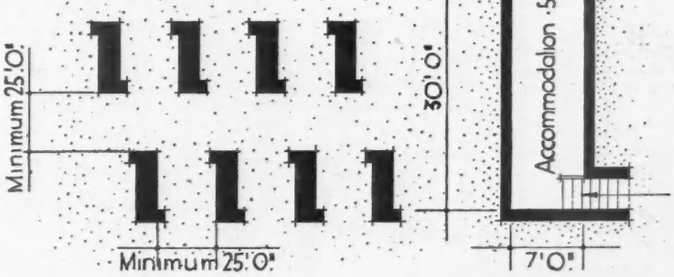


SKETCH SHOWING TYPICAL SUNK SHELTER.


Roof removed to show interior of shelter.
Steel plate or other cover may be used here.
Tunnel type emergency exit (shown in section.)
Easily raised cover, or other protection to opening.
Cat-ladder leading through hatch in roof
Earth cut away to show shelter.

PARTLY SUNK SHELTERS. Except that these can have emergency exits above ground level, they resemble fully sunk shelters in general design.

50-PERSON SHELTERS. The drawing on the right shows a typical sunk shelter to take 50 people, having two entrances, ensuring means of escape & also giving through ventilation. The key plan shows the relative siting of a group of such shelters.



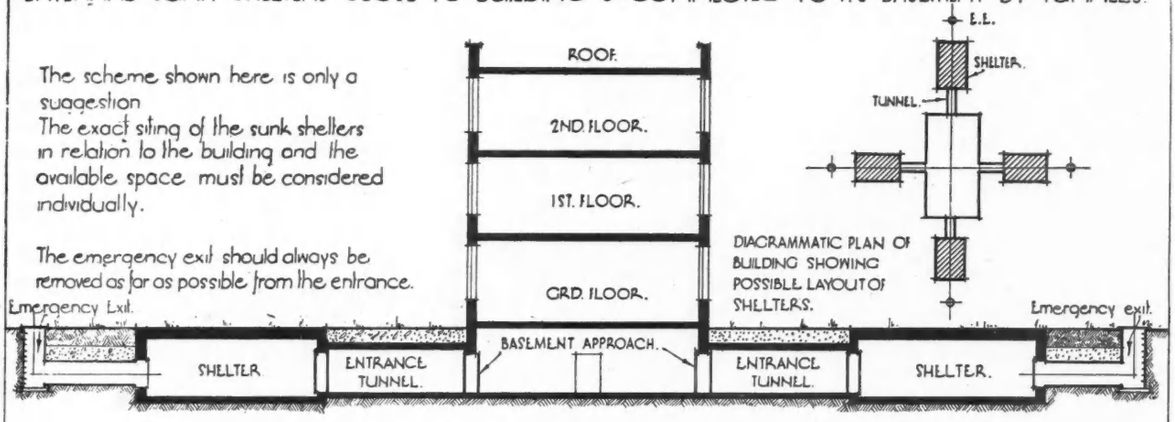
KEY PLAN.

PLAN of single shelter.

EXTERNAL SUNK SHELTERS CLOSE TO BUILDING & CONNECTED TO ITS BASEMENT BY TUNNELS.

The scheme shown here is only a suggestion
The exact siting of the sunk shelters in relation to the building and the available space must be considered individually.

The emergency exit should always be removed as far as possible from the entrance.



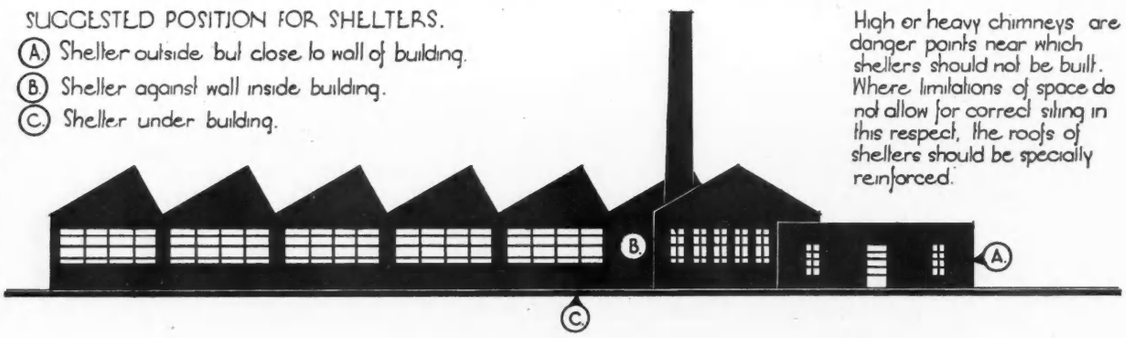
DIAGRAMMATIC PLAN OF BUILDING SHOWING POSSIBLE LAYOUT OF SHELTERS.

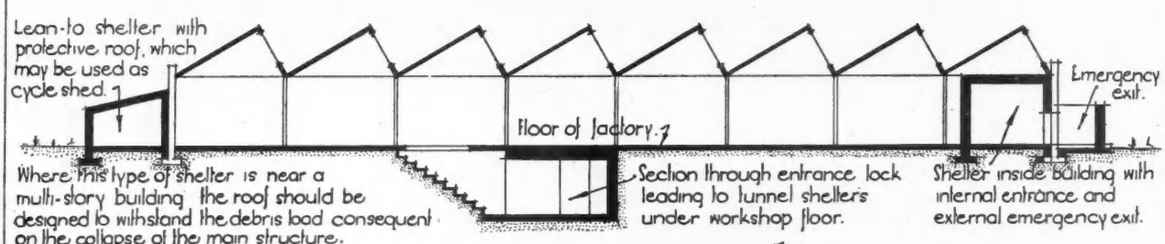
SHELTERS FOR FACTORIES AND COMMERCIAL BUILDINGS.

SUGGESTED POSITION FOR SHELTERS.

(A) Shelter outside but close to wall of building.
(B) Shelter against wall inside building.
(C) Shelter under building.

High or heavy chimneys are danger points near which shelters should not be built. Where limitations of space do not allow for correct siting in this respect, the roofs of shelters should be specially reinforced.

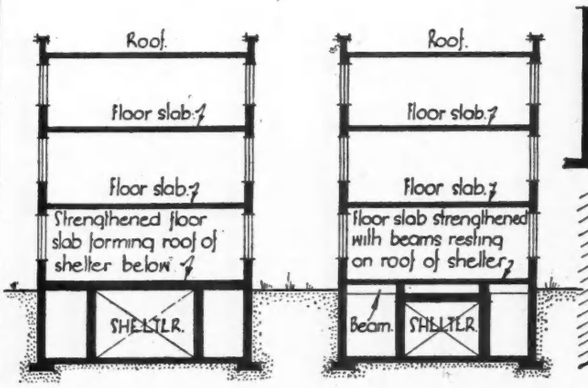




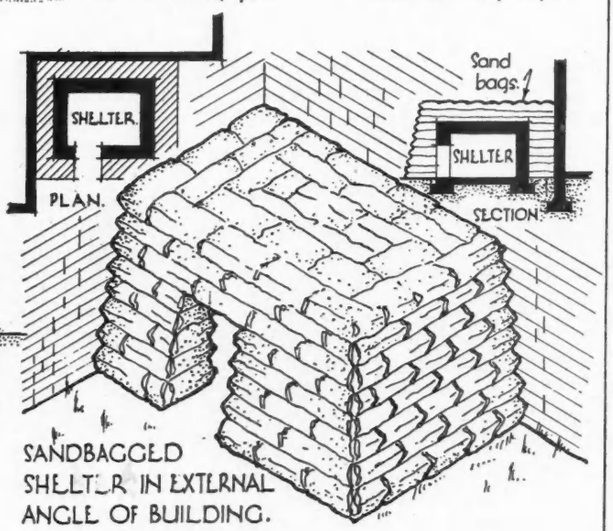
Where this type of shelter is near a multi-story building the roof should be designed to withstand the debris load consequent on the collapse of the main structure.

Section through entrance lock leading to tunnel shelters under workshop floor.

Shelter inside building with internal entrance and external emergency exit.

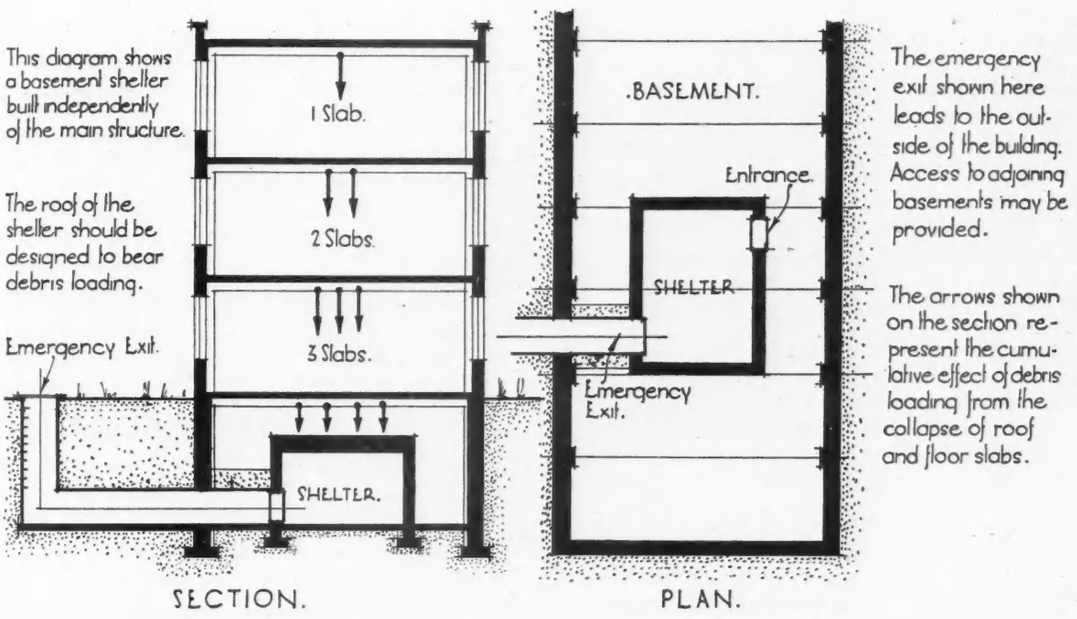


SECTIONS SHOWING TWO METHODS OF CONSTRUCTING BASEMENT SHELTERS.

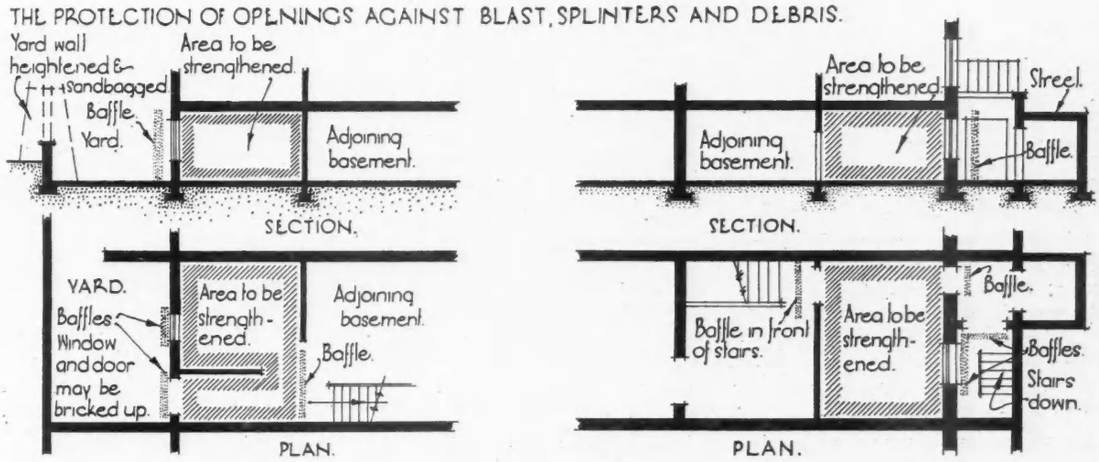


SANDBAGGED SHELTER IN EXTERNAL ANGLE OF BUILDING.

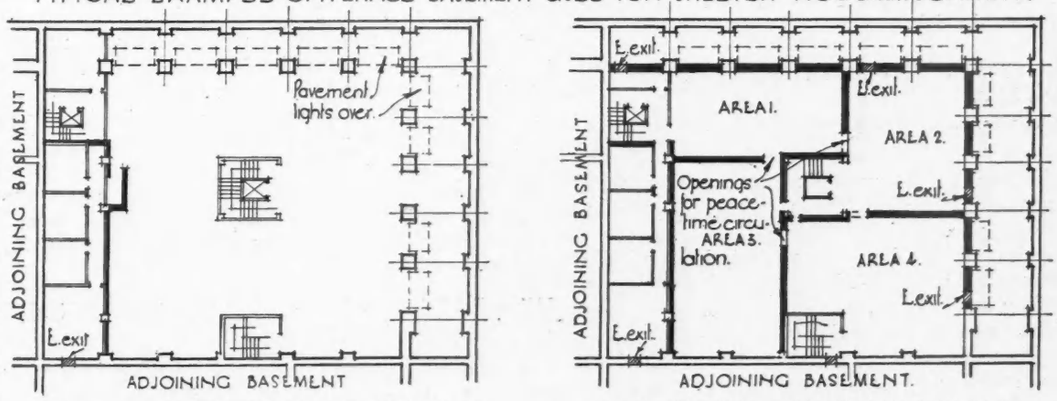
BASEMENT SHELTERS.


This diagram shows a basement shelter built independently of the main structure.
The roof of the shelter should be designed to bear debris loading.
Emergency Exit.
1 Slab.
2 Slabs.
3 Slabs.
SHELTER.
SECTION.
.BASEMENT.
Entrance.
SHELTER
Emergency Exit.
PLAN.
The emergency exit shown here leads to the outside of the building. Access to adjoining basements may be provided.
The arrows shown on the section represent the cumulative effect of debris loading from the collapse of roof and floor slabs.

THE PROTECTION OF OPENINGS AGAINST BLAST, SPLINTERS AND DEBRIS.



TYPICAL EXAMPLE OF A LARGE BASEMENT USED FOR SHELTER ACCOMMODATION.



provided with a hand pump. Where the entrances are formed by long ramps without roofs above, a sump should be formed at the bottom of the ramp, or a step or kerb provided at the entrance to the shelter itself to prevent the entry of water which may accumulate at the bottom of the ramp.

The ground surface should, of course, be graded so that surface water is thrown away from the trenches or their entrances.

In many cases where the permanent water level is near the surface such measures would prove inadequate and waterproofed construction would be required.

In concrete or brickwork the waterproofing would be of the type common in basement and cellar work, with linings of asphalt, bituminous sheeting or other waterproof material, or, in the case of concrete, with waterproofing in the concrete itself.

The trench system of which a diagram is given in the Code is stated to be capable of accommodating 1,200 persons per acre; it is therefore a system which requires 36.3 sq. ft. of space per person.

There will, no doubt, be very many cases where such generous space is not available. In spite of the recommendation contained in the Code that trenches or shelters should be placed at least 25 ft. apart, there does not seem to be any reason for not adopting the same arrangement for closely spaced trench shelters as is allowed by the Code for closely spaced shelters in buildings—". . . Strong dividing walls should be provided between the parties . . . as a working rule the dividing walls should be not less in thickness than twice the thickness of the floor over the shelter if made in reinforced concrete, nor less than three times the thickness of the floor over the shelter if made in brickwork or masonry. In no case may the dividing walls be less than 12 in. thick in reinforced concrete, nor less than 13½ in. thick in brickwork or masonry."

II.—SMALL SHELTERS—ABOVE GROUND.

The standard designs issued for domestic surface shelters are typical of all small surface shelters.

The types which have no baffle wall screening the entrance have no doubt been designed for material economy; the baffle wall types should always be preferred, and if possible they should be so placed that additional protection can be given by sand-bagging in an emergency. Care must, however, be taken to ensure that a roof is not sand-bagged unless it is sufficiently strong to carry the load. It would perhaps be advisable to record on a small notice-board inside every shelter the reinforcement provided in the slab and the maximum sand-bag load which should be put upon it. This might form some check to enthusiastic sand-baggers in times of crisis.

III.—SMALL SHELTERS—PARTIALLY BELOW GROUND.

As has already been pointed out, it is not possible with available information to show by calculation the value of sinking shelters into the ground; there is, however, a fairly widespread conviction that advantage is to be obtained by doing so.

In most cases, if this belief is strongly held, wholly sunk shelters will be provided, but where the problems of waterproofing are difficult, partially sunk shelters may be used. The cost of excavation is reduced by only partially sinking the shelter and the arrangement of entrances and emergency exits is simplified. A minor advantage of the partially sunk shelter over the wholly sunk type is that the emergency exits may be placed in the upper part of the walls as in the surface types.

In wholly sunk shelters the problem is more difficult, and an emergency crawling way must be provided by a large pipe or small duct leading to a manhole.

IV.—SMALL SHELTERS—BELOW GROUND.

Small shelters below ground are comparable in their requirements to trenches and trench systems; in dry ground provision should be made for collecting and removing water percolating through the walls and floor; in wet ground it would be advisable to waterproof the structure.

Steep stairs or ladders are adequate in small shelters for few people, but ramps or stairways should be provided if, say, more than 15 people are accommodated.

V.—LARGER SHELTERS—BELOW GROUND.

Although parties up to 200 in number are permitted, it is recommended that they should be limited to 50 wherever possible; for this reason large shelters will tend to become merely multiple combinations of a standard 50-person shelter, the dividing walls being of the strength laid down and referred to under "Trenches and Trench System."

Fifty-person shelters, because they are conveniently arranged as a long rectangle, with entrances at each end, tend to become almost the same as the components of a trench system, but with the difference that adequate entrances can be arranged more readily.

The requirements for the construction of the walls and roofs, the drainage and waterproofing, and the space requirements, are the same as for the other types of shelters already outlined.

VI.—TRENCHES IN BUILDINGS.

Shelters or trench systems built under the ground floor of non-basement buildings are particularly recommended in the Code, but the buildings above should be well constructed and preferably of framed construction; the fire hazard must be low, and adequate emergency exits to the outside air (and outside the probable debris zone) must be provided. On new buildings, where the work of construction can be carried out in the open, the cost will be relatively low, but in existing buildings, where either the existing floor must be cut out or tunnelling adopted, the cost would be considerably higher.

The roof over the shelters or trenches must be capable of carrying the loads laid down for the roofs of basement shelters in addition to any normal loads.

In many cases where such shelters are constructed under existing buildings it will be both convenient and an advantage to build the trench or tunnel shelter entirely separate from the existing structure. The roof of the shelter is then independent of the floor above and may be designed either to take the debris loading laid down, or as a light slab, the floor above, if suitable, being strengthened to take the debris loading. The entrances to shelters of this kind will usually be arranged inside the building for easy access; they will not, therefore, form good emergency exits nor provide very effective natural ventilation.

Separate emergency crawling ways should, therefore, be provided leading to the outside air, if possible beyond the debris zone, and it is preferable that they should lead to baffled exits rather than manhole covers. A crawling way open at the end, but protected by a baffle wall, will assist in providing natural ventilation for the shelter.

VII.—BASEMENT SHELTERS AND STRENGTHENED BASEMENTS.

In considering the provision of shelters in basements, reference should be made to Air Raid Precautions Memorandum No. 10, "Provision of Air Raid Shelters in Basements," in which the standards of protection laid down are:—

LATERAL PROTECTION—provided by the earth for portions below ground; for portions above ground the requirements are as for surface shelters.

OVERHEAD PROTECTION—Slabs or brick arches as required for other shelters, and if debris loading is to be expected, they must be capable of carrying the debris loads specified above, according to the type of structure over.

The work required in preparing existing basement rooms as shelters consists mainly of strengthening or propping the floor above, building up windows and doors or building baffle walls to screen them, and in some cases strengthening the walls.

The following diagrams and tables, taken by permission from the Memorandum quoted above, indicate the methods which are recommended for this class of work :—

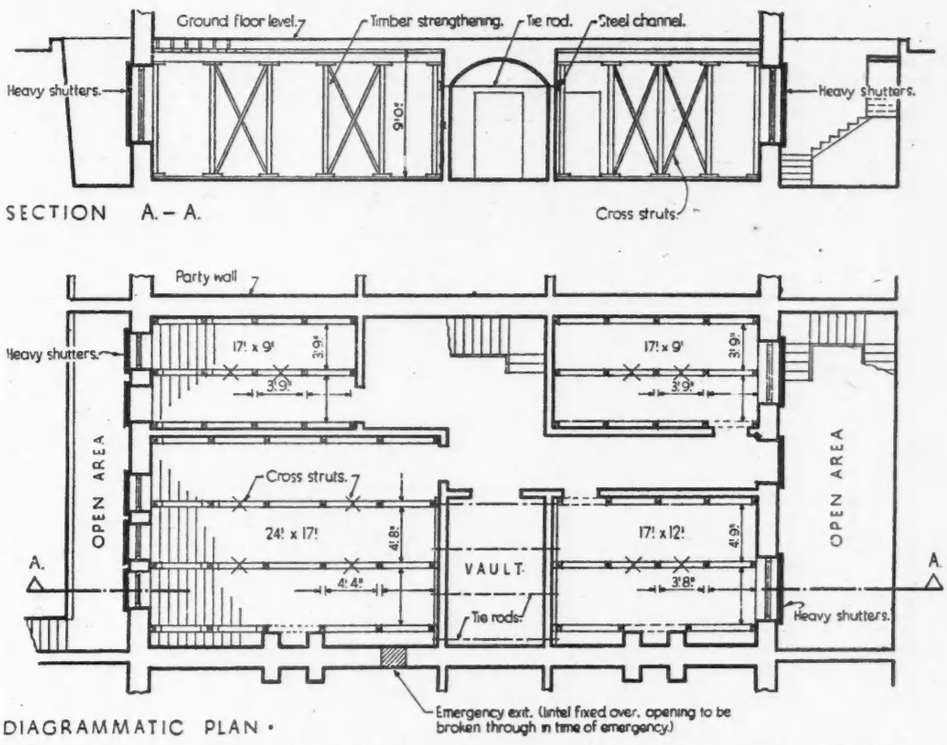


FIG 1.—EXAMPLE OF TYPICAL BASEMENT STRENGTHENED WITH TIMBER FOR A DEBRIS LOAD OF 400 LB. PER SQ. FT.

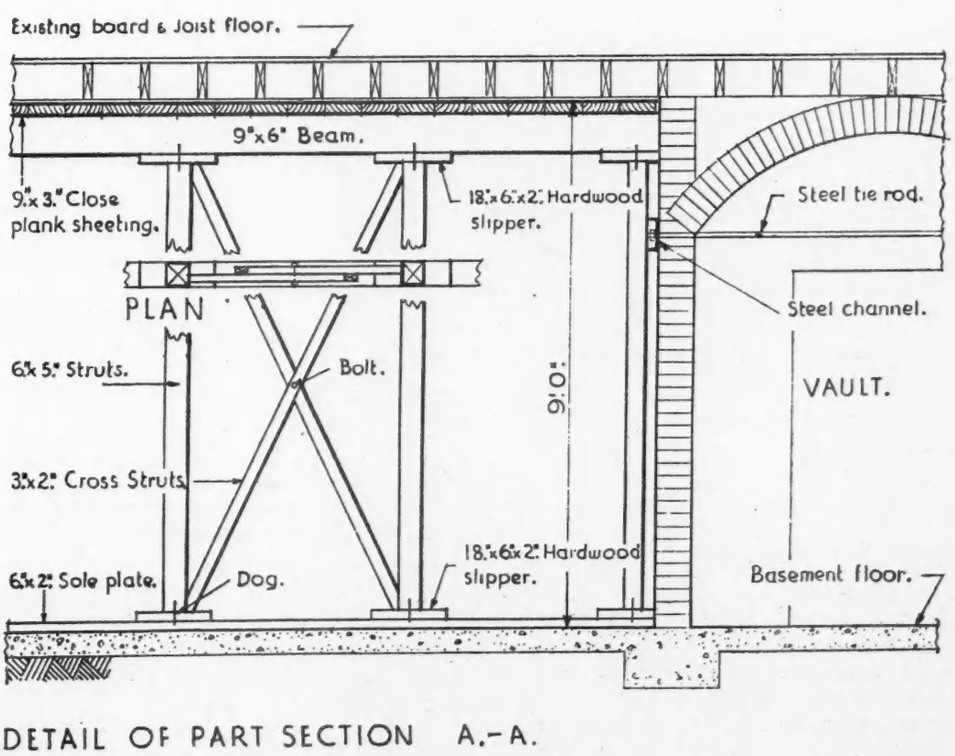


FIG. 1a.—DETAILS OF TIMBER STRENGTHENING.

APPENDIX I.—DIMENSIONS OF TIMBER SUPPORTS TO BE USED IN STRENGTHENING FLOORS OVER SHELTERS.

The following tables will assist architects and builders in choosing timber for the strengthening of floors over air raid shelters.

It has been assumed that most systems of strengthening will involve the use of close sheeting under the existing floor which, with timber, will take the form of heavy planks. The sheeting will be supported by beams with struts under, the struts resting on timber sole pieces.

The dimensions of timbers are given in terms of their working span for three different debris loads and for two grades of timber. The lower working stress of 800 lb. per sq. in. is appropriate for the common, carcassing class of European redwood and the higher working stress of 1,200 lb. per sq. in. represents a suitable value for timber equal to No. 1 Merchantable (UKAY) grade of Douglas fir.

Two arrangements of plank sheeting are given. The one provides for close sheeting and the other for 9 in. wide planks spaced 3 in. apart. The latter arrangement has been used on some schemes, and is convenient where there are pipe runs, etc., below the existing ceiling. The two arrangements are shown in Figures 1 and 2.

Dimensions of struts are given for four different heights of basement ceiling above floor level.

TABLE I.

9 in. × 3 in. Plank Sheeting, Laid Flat and Closely Spaced.

Debris load lb./sq. ft.	Clear span of sheeting = L (in.).		Size of beams (in.).	Clear span of beams = S (in.).		Sizes of struts (in.) for ceiling height above floor level = H.							
						7 ft. 6 in.		8 ft. 6 in.		9 ft. 6 in.		10 ft. 6 in.	
	f = 800 lb./sq. in.	f = 1200 lb./sq. in.		f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.
200	83	102	6 × 6	42	47	6 × 3	6 × 3	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4
			6 × 9	63	70	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4
300	68	83	6 × 6	39	42	6 × 3	6 × 3	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4
			6 × 9	58	64	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4	6 × 5	6 × 4
400	59	72	6 × 6	35	39	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4
			6 × 9	53	59	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4	6 × 5	6 × 5

NOTE.—f = working fibre stress of timber.

Slippers. Hardwood (oak, beech, birch, rock maple) slippers 6 in. × 18 in. × 2 in. to distribute loads from struts to beams and sole pieces.

Sole pieces. 6 in. × 2 in.

Cross Bracing. 3 in. × 2 in. cut to fit and joined at intersection.

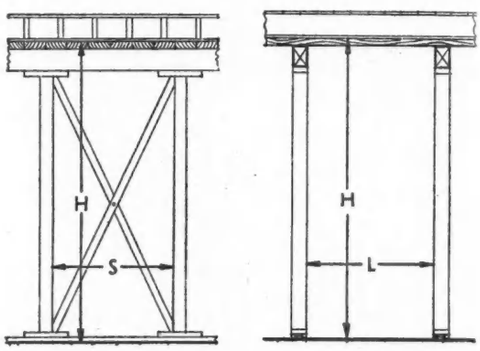


TABLE II.

9 in. × 4 in. Plank Sheeting. Laid Flat and Closely Spaced.

Debris load lb./sq. ft.	Clear span of sheeting = L (in.).		Size of beams (in.).	Clear span of beams = S (in.).		Sizes of struts (in.) for ceiling height above floor level = H.							
						7 ft. 6 in.		8 ft. 6 in.		9 ft. 6 in.		10 ft. 6 in.	
	f = 800 lb./sq. in.	f = 1200 lb./sq. in.		f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.
200	111	96	6 × 6	37	41	6 × 3	6 × 3	6 × 4	6 × 3	6 × 4	6 × 4	6 × 4	6 × 4
			6 × 9	56	61	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4	6 × 5	6 × 4
300	90	78	6 × 6	34	37	6 × 4	6 × 3	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4
			6 × 9	50	56	6 × 4	6 × 4	6 × 5	6 × 4	6 × 5	6 × 4	6 × 5	6 × 5
400	78	68	6 × 6	31	35	6 × 4	6 × 3	6 × 4	6 × 4	6 × 5	6 × 4	6 × 5	6 × 5
			6 × 9	47	52	6 × 4	6 × 4	6 × 5	6 × 4	6 × 5	6 × 4	6 × 5	6 × 5

NOTE.—f = working fibre stress of timber.

Slippers. Hardwood (oak, beech, birch, rock maple) slippers 6 in. × 18 in. × 2 in. to distribute loads from struts to beams and sole pieces.

Sole pieces. 6 in. × 2 in.

Cross bracing. 3 in. × 2 in. cut to fit and joined at intersection.

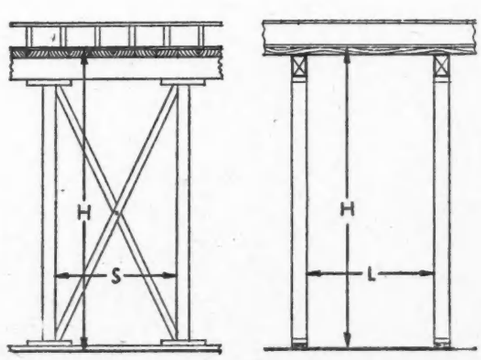


TABLE III.

9 in. × 3 in. Plank Sheeting, Laid Flat, with 3 in. Clear Space between Planks.

Debris load lb./sq. ft.	Clear span of sheeting = L (in.).		Size of beams (in.).	Clear span of beams = S (in.).		Sizes of struts (in.) for ceiling height above floor level = H.							
						7 ft. 6 in.		8 ft. 6 in.		9 ft. 6 in.		10 ft. 6 in.	
	f = 800 lb./sq. in.	f = 1200 lb./sq. in.		f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.	f = 800 lb./sq. in.	f = 1200 lb./sq. in.
200	72	88	6 × 6	45	52	6 × 3	6 × 3	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4
			6 × 9	68	78	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4
300	59	72	6 × 6	41	46	6 × 3	6 × 3	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4
			6 × 9	61	69	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4
400	51	62	6 × 6	39	43	6 × 4	6 × 3	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4	6 × 4
			6 × 9	58	65	6 × 4	6 × 4	6 × 4	6 × 4	6 × 5	6 × 4	6 × 5	6 × 5

NOTE.—f = working fibre stress of timber.

Slippers. Hardwood (oak, beech, birch, rock maple) slippers 6 in. × 18 in. × 2 in. to distribute loads from struts to beams and sole pieces.

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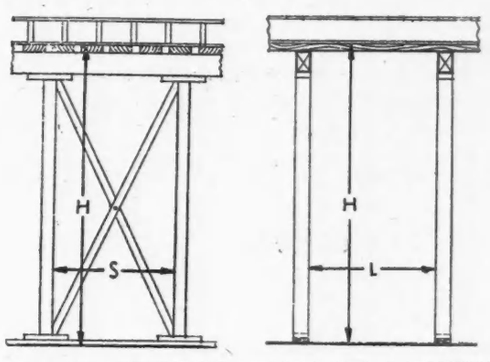
Cross bracing. 3 in. × 2 in. cut to fit and joined at intersection.



APPENDIX II.—SPECIAL STEEL STRUTTING FOR BASEMENTS.

List of Parts.

The following is a list of the items provided for the strutting of basements by steel:—

(1) Corrugated steel sheets, 14 B.G. finished black, with 5/5 in. corrugations, in lengths of 6 ft., 7 ft., or 8 ft. and in width 2 ft. 4 in.

(2) Rolled steel joists 4 in. × 3 in. × 10 lb. finished with one coat of red oxide or black bitumastic solution.

(3) Struts, consisting of a head clip, a steel tube and a screw-jack base, the latter itself comprising a screw spindle riveted to a base plate and carrying a threaded bush.

The parts and their relationship *in situ* are shown in Figures 2 and 2*a*.

Placing the Sheets.

The corrugated steel sheets are to be placed in close contact with the existing ceiling joists, the corrugations and joists running parallel.

The sheets are to be lapped at the edges where they meet, the minimum lateral lap being one corrugation, and the minimum longitudinal lap being 1 ft. 6 in.

The longitudinal lap is to be so arranged that it is supported by a rolled steel joist, the centre line of which is not less than 9 in. distant from the end of either sheet.

Placing the Joists.

The rolled steel joists are to be placed at right angles to the direction of the floor joists, at a maximum spacing of 5 ft. from centre to centre, with a maximum distance of 1 ft. 6 in. between the side wall and the centre of the nearest joist, and are to be cut and pinned into the supporting walls a minimum of 4½ in. at either end.

Placing and Erecting Struts.

The struts shall be placed at not more than 5-ft. centres along each joist, and the distance between the side wall and the nearest line of struts shall not exceed 1 ft. 6 in.

The struts are erected as follows:—

The bush is located at the bottom of the screw-spindle, which, together with the attached base-plate, should then be placed in its proper position on the floor. The tube is placed over the spindle to rest upon the shoulders of the bush and adjusted at the top to engage the head clip by which it is affixed to the joist. Adjustment for height is made by turning the bush on the spindle and the adjustment should be such that the joist and tube are in direct contact without the tube exerting any material upward pressure.

The strut should finally be checked to see that it is truly vertical and in overall height not greater than 9 ft.

If the struts are not to be erected until the basement is needed for shelter, then the positions of head clips and bases should be clearly marked on the joist and floor, and the struts removed to suitable storage.

It may be desirable in some cases to mark the struts with references showing their location.

Size of Building and Size of Basement.

The special steel strutting of the type here described is intended for use in the basements of the smaller type of houses with timber floors and not more than three storeys over the basement. The size of basements must be such that the maximum dimension parallel to the line of the rolled steel joist shall not exceed 13 ft., and the maximum dimension at right angles to the rolled steel joist shall not exceed 18 ft.

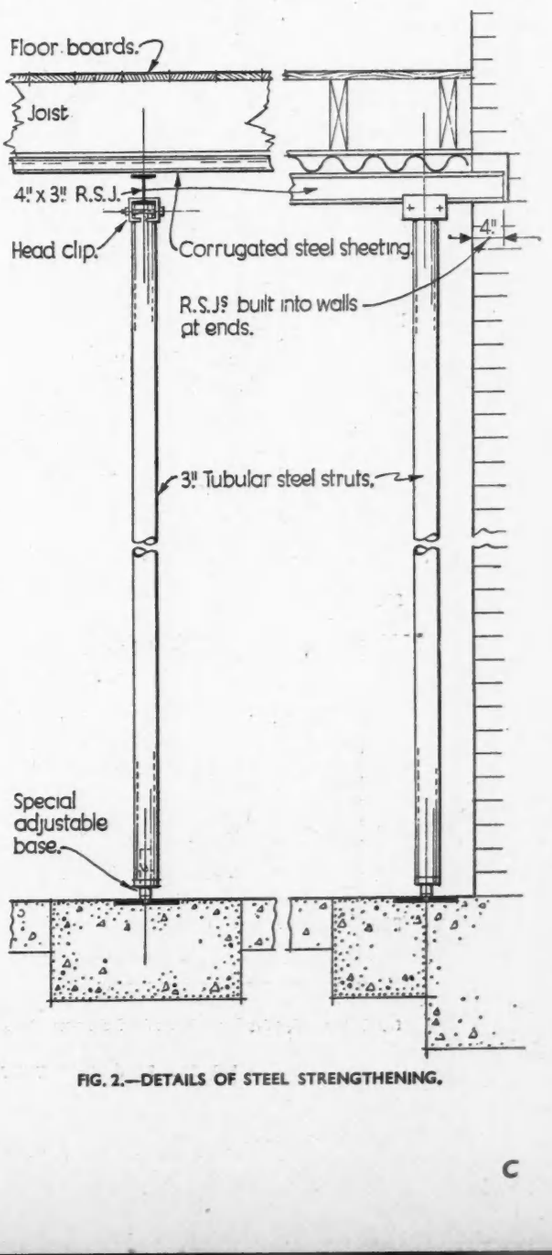
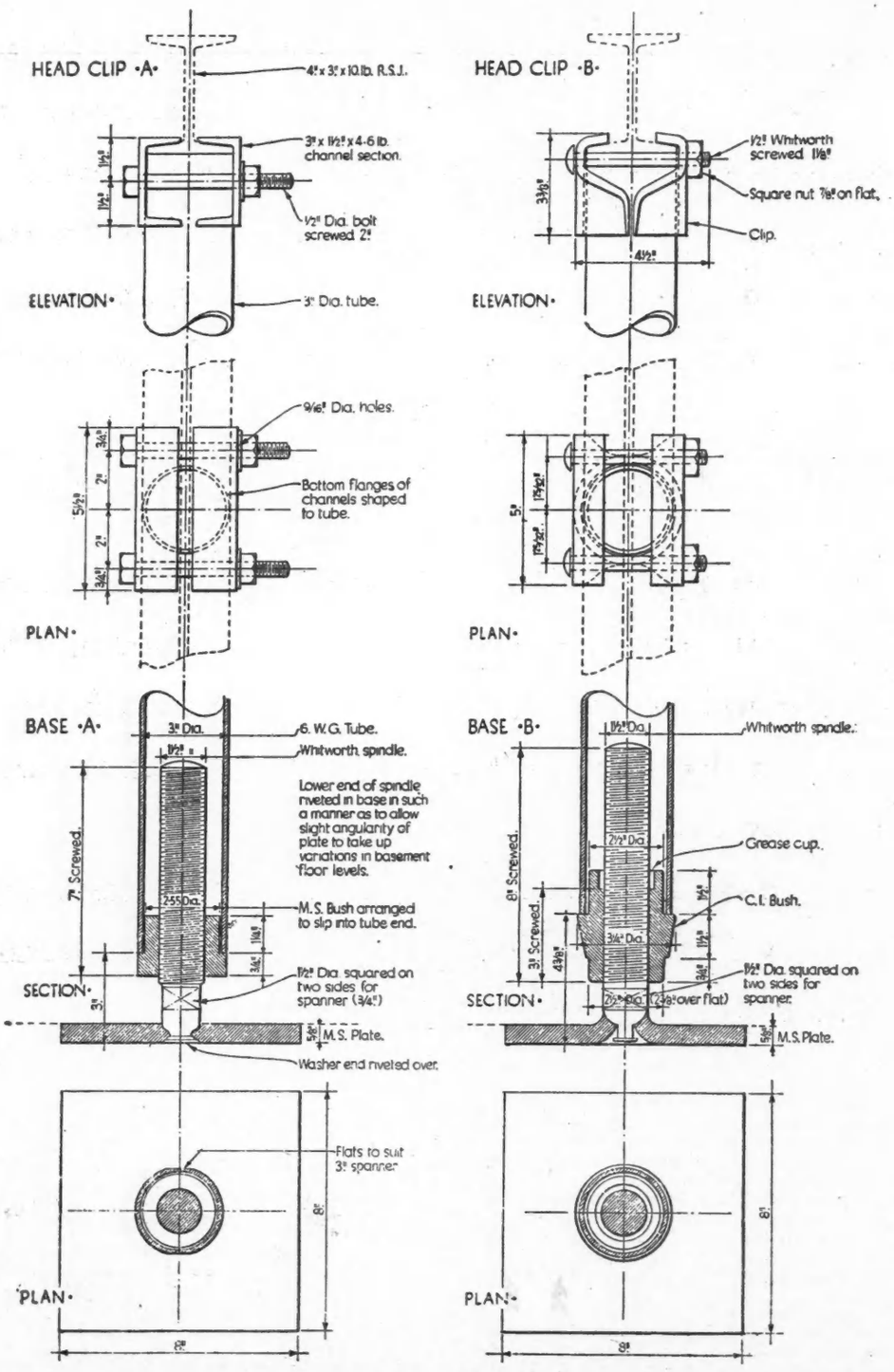


FIG. 2.—DETAILS OF STEEL STRENGTHENING.

Such methods of strengthening and strutting may be adequate in small basements or basements which are divided into small rooms with solid walls. A variety of unknown factors must, however, affect the efficiency of such shelters, including the stability of the structure as a whole, the condition of the walls and floors and amount of bearing obtained by existing structural members. Where, therefore, the space is available and economy not the most important factor, it would be preferable and more effective to build within the basement a separate and free-standing shelter with the walls and roof independent of the main structure. Such a shelter would probably show a very great increase, particularly in lateral protection. With regard to the general principle of separating shelter structures from those of the basements in which they are erected, although there is not at the moment any definite data available on the question of insulation from shock wave, it is generally understood that the fact that only one face of the shelter (the floor) is in direct mechanical contact with the building or the surrounding earth would mean a very considerable increase in insulation. The walls might be 9 in. brickwork (or its equivalent) and if built away from the external basement walls would not be affected if the external walls were damaged. Large openings in the external walls would, of course,



NOTE: Head clips A & B and bases A & B are alternatives. Either head clip can be used with either base.

FIG. 2A. DETAILS OF TUBULAR STEEL STRUTS (APPENDIX II).

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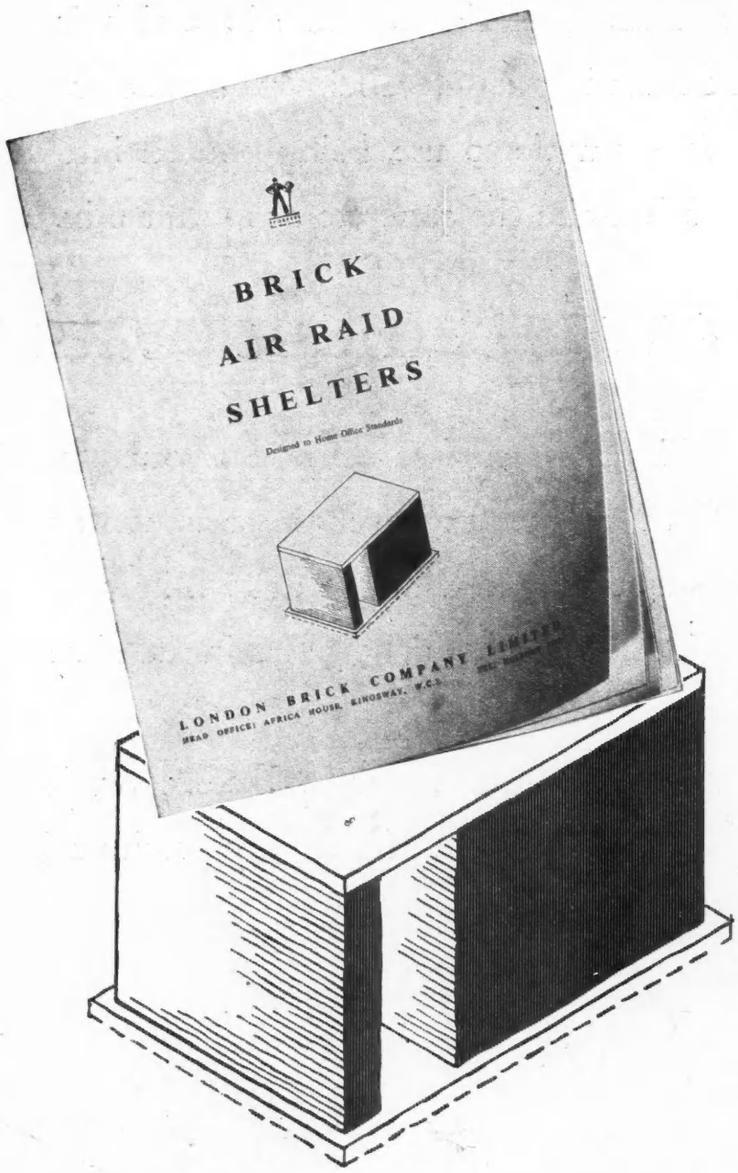

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require to be protected or built up as a protection against fragments.

If sufficient head room were not available in the existing basement it would in many cases be possible to sink the shelter itself sufficiently to enable its roof to be built separate from the floor above.

The roof of the shelter would, owing to limitations of space, require to be built up of units since it would be difficult to carry out *in situ* concrete work. Roofs of precast concrete, steel joists and steel sheeting or slabs, or of wood joists set close together, would serve the purpose.

The entrances to the shelter proper could be arranged so that the walls of the existing building served as baffles.

The entrance ways and emergency exit ways would, of course, have to be provided and protected as for other basement shelters.

A.R.P. SHELTERS, ETON COLLEGE

By G. R. FALKINER NUTTALL, A.M.Inst.C.E.

In December, 1938, at the request of the Headmaster, the writer, in collaboration with Mr. Elliott Cooper, prepared a report on the A.R.P. measures of a structural nature, which we recommended Eton College to carry out.

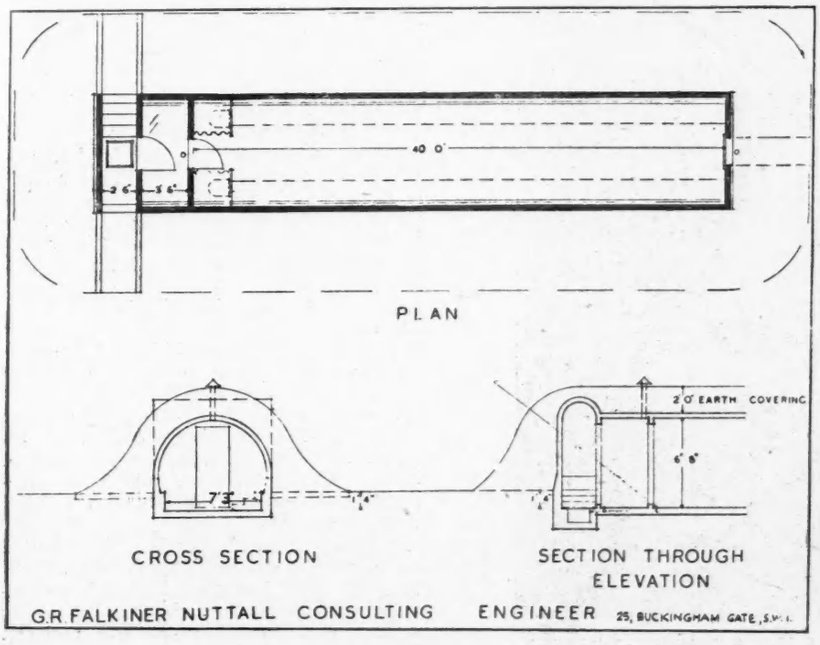
Our report was divided into two sections (a) Protection of Life, and (b) Protection of Buildings. This article will be restricted to the protection of life, as the work envisaged in the report is nearing completion and the means adopted are applicable elsewhere, where shelters have to be provided in localities which are subject to flooding.

VIEW SHOWING COMPLETED CONCRETE WORK, BEFORE THE EARTH-WORK COVERING WAS ADDED.

The General Scheme.

Independent shelters were decided on as the buildings are of brick construction without framework and with one exception had no basements which could be propped up to give protection against splinters and falling debris. The provision of protection against direct hits was ruled out as, in order to be economical, large shelters would have to be built, which would obviously be very costly to construct in waterlogged ground and not be as easy to reach as a large number of shelters of smaller size within easy reach of the houses.

It was decided to provide: (1) Gas-tight doors (of steel) at the entrances of shelters, to give protection against blast and to avoid the necessity of using gas masks for short periods; (2) Natural Ventilation. This could be maintained by opening of door and vents through the roof. Mechanical ventilation was not ruled out if it was decided later that it would be necessary to use the shelters with doors and vents closed for long periods; (3) Air Lock Partitions, so that an air lock could be rapidly improvised if required; (4) An emergency exit 2 ft. diam. In peace-time this could be left open, giving additional natural ventilation; (5) Chemical Closets; (6) Electric Light; (7) 2 ft. earth covering, so that grass, bushes, etc., could be grown over them; (8) Protection against flood water rising 1 ft. above ground level; (9) Protection against falling debris. 2 cwt. per sq. ft. normally and 4 cwt. per sq. ft. where the shelter is near a heavy building; (10) Protection against splinters and blast (for earth-covered shelters, when earth is regarded as the means of protection, the Home Office requirement is 2 ft. 6 in. of earth for lateral protection. In accordance with the requirements of the Code, to form part of the Civil Defence Bill, the overhead protection required is 1 ft. 6 in. of earth or 4 in. of concrete of structural quality.



PLAN AND SECTIONS OF A SHELTER.

A number of schemes had been made to determine costs of shelters to meet the above requirements. If the door is to be adequately protected against blast the entrance represents a considerable part of the cost, and therefore for less than 50 persons the cost per head rises appreciably. The average number of boys and staff per house was found to be 60, and alternative schemes were considered by the school authorities, one for a single shelter, as shown in the drawing reproduced, for a maximum of 60 boys costing £5 per head, and the alternative slightly more expensive scheme, with entrance in middle, providing two compartments for 30 boys each.

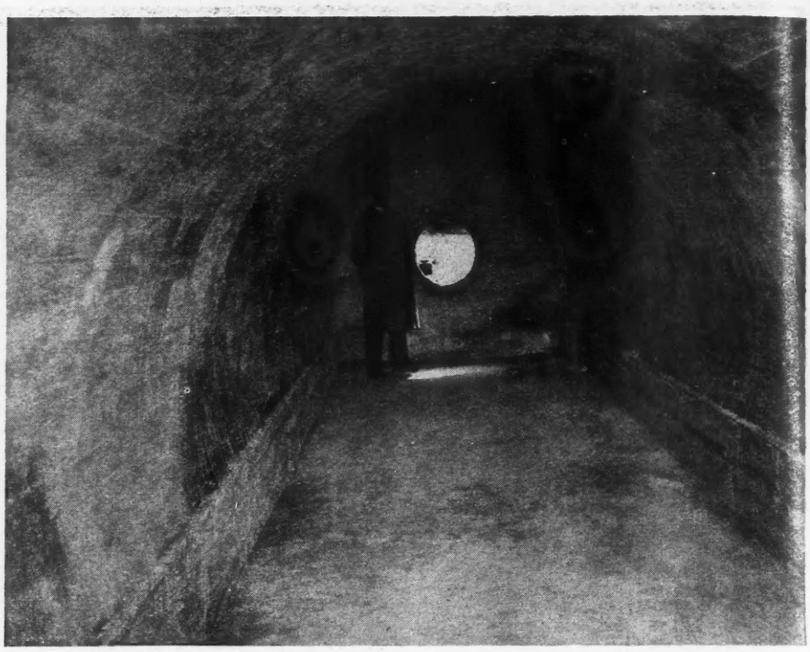
Site considerations and cost favoured the first scheme and the work is now being carried out at approximately the estimated price, most of the shelters, of which there are 27, being built by Messrs. John Deverill, Ltd., of Slough. In addition, there are two other shelters which have been incorporated in new buildings and have an alternative use in peace-time.

The headmaster, the junior bursar, the manager of the school works dept., Mr. Skipp, spent a great deal of time with success in finding sites which were accessible and yet did not spoil the gardens. The housemasters were also very helpful in arriving at the best solution.

I will now turn to the more technical points in the design of the shelters shown in the drawing. The arched type of roof as used in the "Anderson Shelter" was adopted, the width being such that after placing benches along each side tables could be placed along the centre of the shelters so that the boys could carry on with their work if necessary.

The floor area of the shelter is 40 ft. by 7 ft. 3 in. = 290 sq. ft. The floor space per person is just under 5 sq. ft. (The minimum permitted for a tunnel shelter by the Provisional Code is fixed at 3¾ sq. ft. per person.) The size of the shelter could have been smaller, as the width would permit three rows of persons being accommodated in benches, but this would have been uncomfortable and would not have given any room for tables.

The entrance was given special attention and the door is well protected from blast, as the arrangement permits of the blast passing straight through the entrance opening, which is at right angles to the main shelter. The door is also reasonably well protected against splinters, which can only strike it at an angle. A threshold cross-piece 1 ft. above ground level was provided at the entrance to prevent flood water entering. This permitted the top of the entrance hood being kept below the top of the earth of the main shelter. Steps down to floor level are provided under the entrance hood, terminating in a sump covered with a teak grating. The sump will collect rain driving into the entrance and is also connected by drains (which can be plugged) to the air lock and shelter.



THE INTERIOR OF A SHELTER, ETON COLLEGE.

A depth of floor level could have been chosen so that sufficient earth from the excavation could have been obtained to avoid bringing earth from the outside for the earth covering. As, however, the ground is subject to flooding and the shelter might get damaged and let water in, a maximum depth of 2 ft. 4 in. below maximum flood level was chosen for floor level—*i.e.*, 1 ft. 4 in. below ground level. The lower part of the shelter, therefore, required to be designed as a tank 2 ft. 4 in. deep. Reinforced concrete was the obvious material to use, "Tricosal" being added.

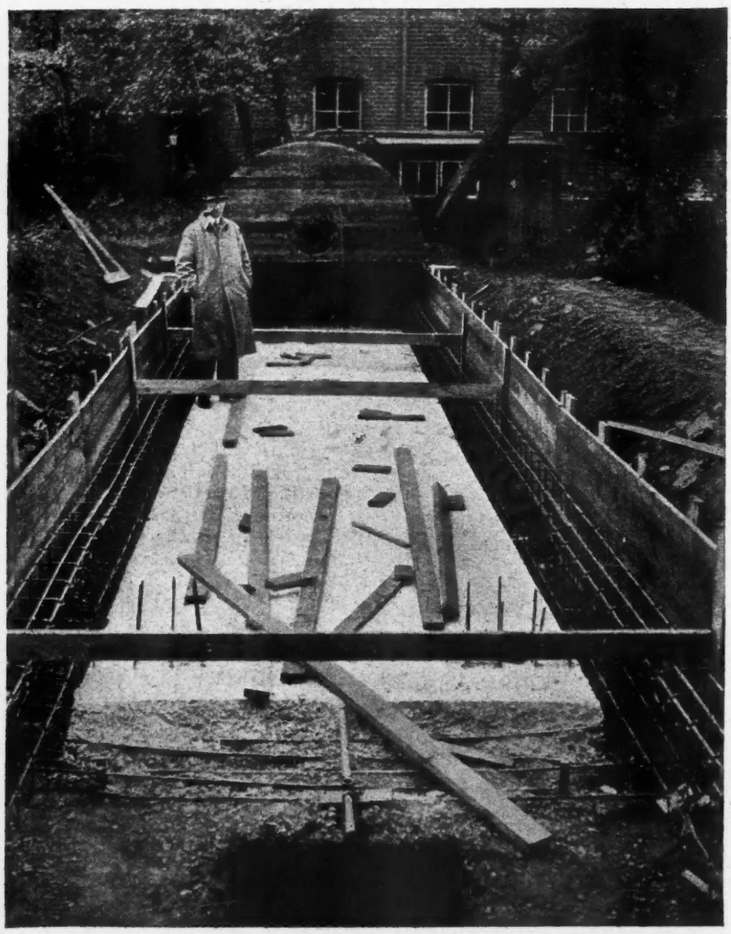
A 6 ft. 4 in. by 2 ft. 6 in. door, as can be seen in the drawing, works in well with a radius of 4 ft. for the upper part of the main shelter, which could be steel or reinforced concrete. Reinforced concrete was selected in preference to steel, as there was practically no difference in cost and the concrete has the advantage of reducing maintenance charges to a minimum. Two coats of R.I.W. have been applied to the outside of the concrete.

The reinforcement of the structure presents no unusual problem.

In the original design for the curved part of shelter I had included for a reinforcement used in Germany for shelters, and which has been tested satisfactorily by the War Office. The reinforcement was manufactured under the "Benzinger" patent and is a mesh made up from wire-netting and bars, the cross section being a series of triangles 3 in. deep. This reinforcement gives very great security from scabbing of the concrete on the inside when the shelter receives a blow on the outside.

It was not possible to obtain sufficiently rapid supplies of this special reinforcement, and therefore, as an alternative, No. 6 "Exmet" (1½ in. mesh) reinforcement was used in addition to normal reinforcement.

If this type of shelter is to be adopted on a large scale, steel shuttering should preferably be used, for which I have prepared designs and which, for the curved section, costs no more than £70, and can be got out of the emergency exit or entrance with ease.



A SHELTER UNDER CONSTRUCTION. THE FLOOR SLAB IS COMPLETED, AND THE REINFORCEMENT FOR WALLS IS BEGINNING TO RISE.

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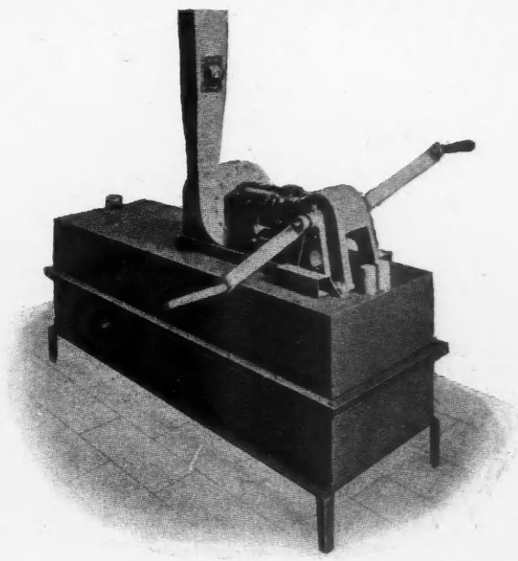

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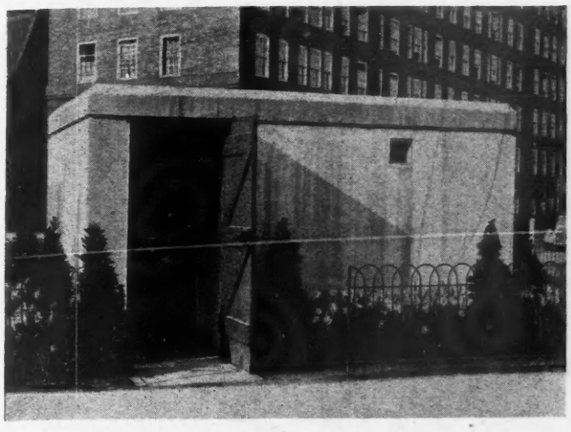
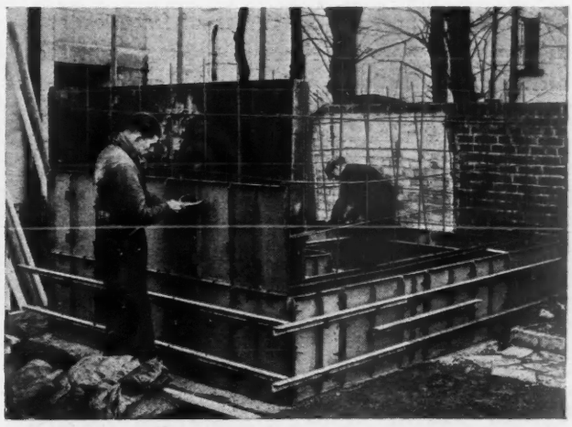
PILL-BOX DUAL-PURPOSE A.R.P. SHELTER



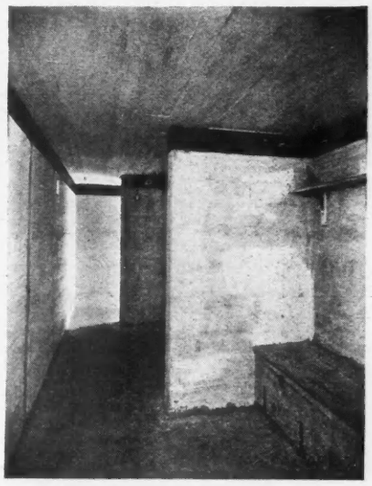
A CONCRETE PILL-BOX SHELTER, CHELSEA.



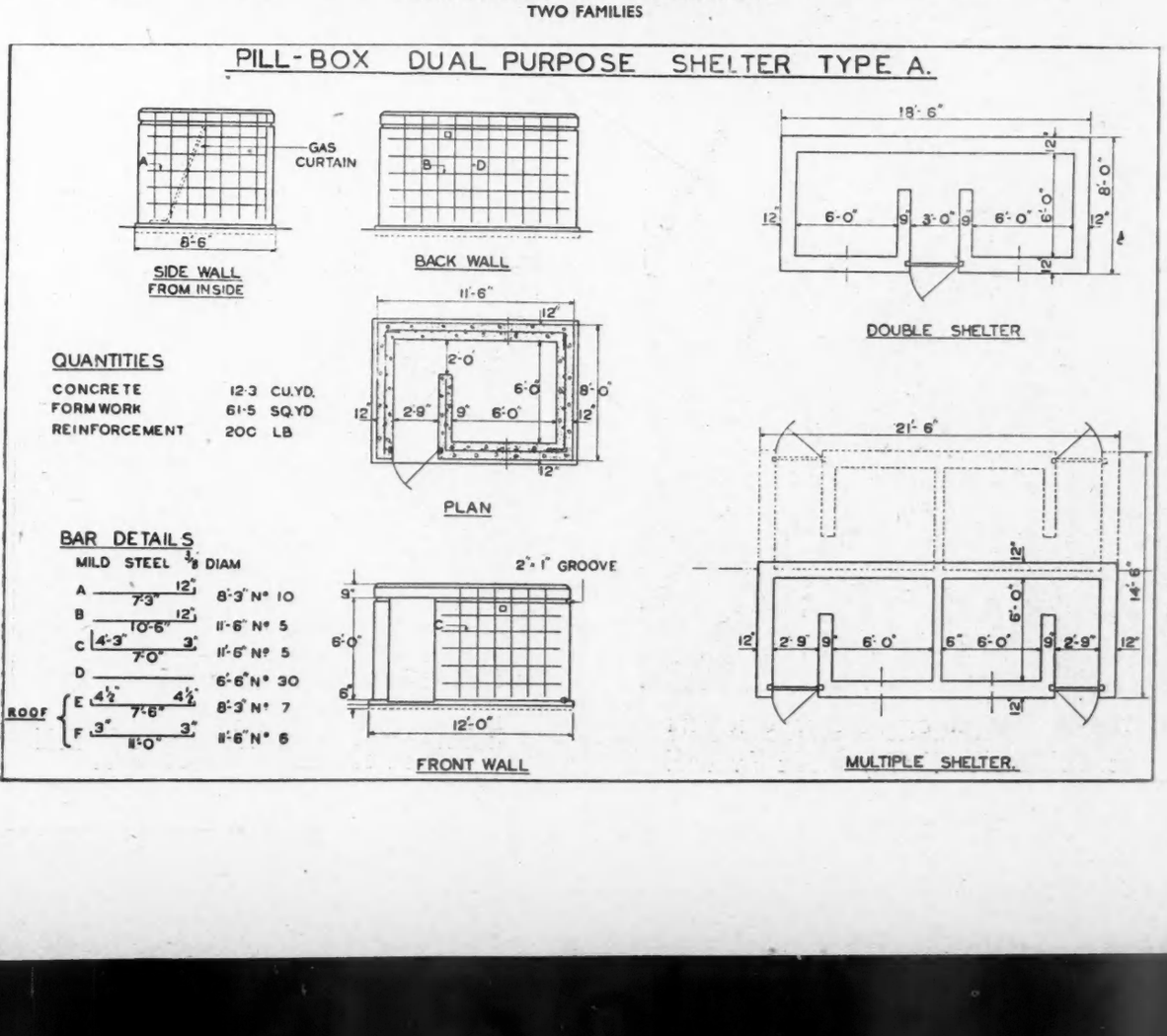
ASSEMBLING THE STEEL FORMWORK.

A PILL-BOX A.R.P. shelter, which gives protection against blast and splinters, is not unsightly and may be used in normal times for a variety of purposes, has been designed by the Cement and Concrete Association. A large number of these shelters have already been erected.

The foundations should rest in well-consolidated ground. On the drawing reproduced they are shown as a 6-in. slab incorporated with the floor, but they may be extended and deepened if required. The concrete should be the equivalent of a 1 : 2½ : 4 mix. Ten per cent. of hydrated lime may be added to the cement before mixing. The maximum size of coarse aggregate should be 1½ in. At the junction of the wall with the roof or floor and at any other horizontal joints, a longitudinal groove should be formed in the concrete to provide a key. Timber plugs 2 in. by 1½ in. dovetailed for fixing hooks, shelving, etc., should be set flush in walls 12 in. apart, 9 in. down from ceiling. Two tapered vent holes should be formed in the walls and in the positions shown in the drawing. The holes should be 4 in. square on inner face, 7 in. square on outer face and each fitted with a concrete plug having contact faces covered with plywood. The door should be 1 in. thick, ledged and hung to a 4 in. by 3 in. timber frame set flush in the walls and secured by iron hold-fasts or bolts. A timber combined bench and locker should be fixed along one side of the shelter. Variations of this design are available.



INTERIOR VIEW OF A DOUBLE CONCRETE PILL-BOX SHELTER, BUILT TO ACCOMMODATE TWO FAMILIES

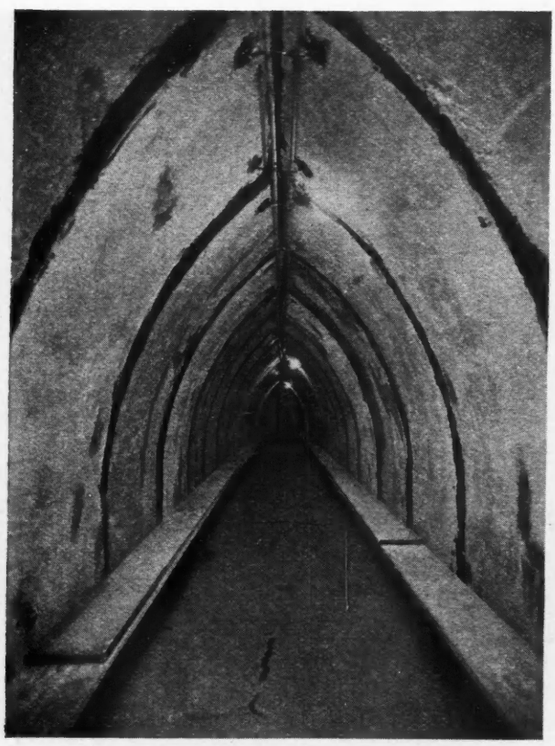


A SCHEME OF SHELTERS FOR A LONDON FACTORY

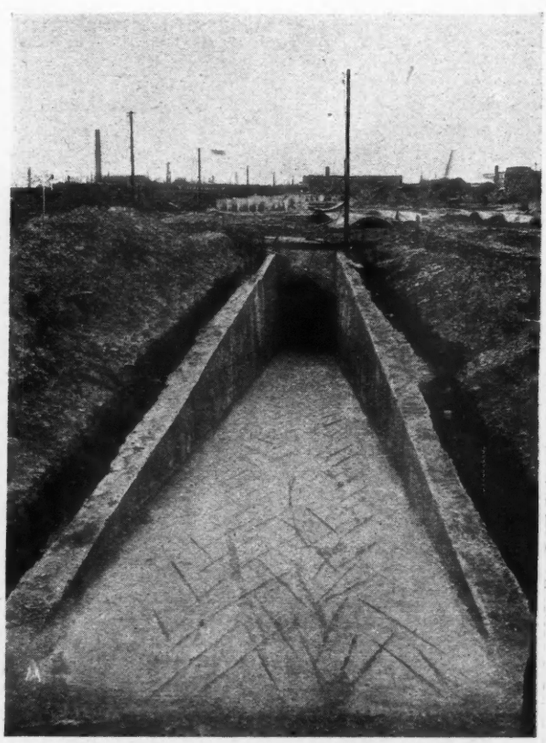
Where space permits, a number of factories are relying upon trench shelters of pre-cast concrete arch sections, built up, jointed with cement, and then covered with earth. Illustrations on this page show such a scheme and the method of construction and types of finish. The units are cast on the spot, steel shuttering being used.

TRENCH SHELTER OF PRE-CAST CONCRETE ARCH SECTIONS UNDER CONSTRUCTION IN THE GROUNDS OF A LONDON FACTORY. VIEW SHOWS PRE-CAST SECTIONS, JOINTED TOGETHER WITH CEMENT, AND EMERGENCY EXITS.

TRENCH SHELTER OF PRE-CAST CONCRETE ARCH SECTIONS UNDER CONSTRUCTION IN THE GROUNDS OF A LONDON FACTORY. LOWERING SECTIONS INTO POSITION IN EXCAVATED TRENCH.



TRENCH SHELTER OF PRE-CAST CONCRETE ARCH SECTIONS IN THE GROUNDS OF A LONDON FACTORY. VIEW SHOWS INTERIOR.



ENTRANCE TO TRENCH SHELTER. SHELTER CONSTRUCTED WITH PRE-CAST CONCRETE ARCH SECTIONS, EARTH-COVERED.

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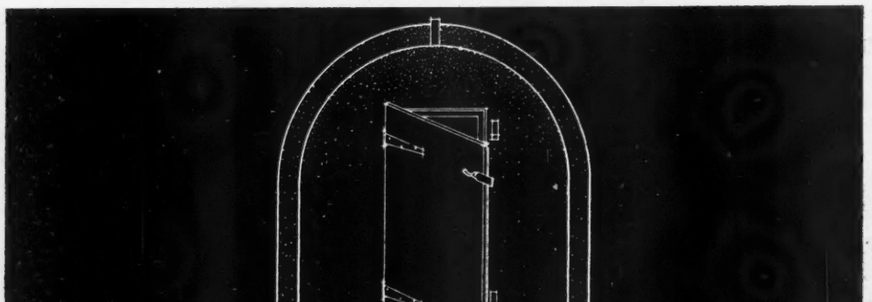
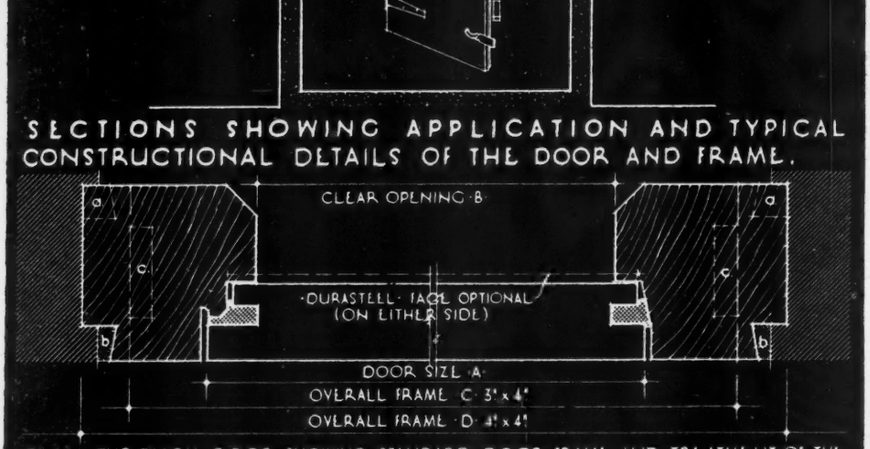
THE SANDELL A.R.P. DOOR

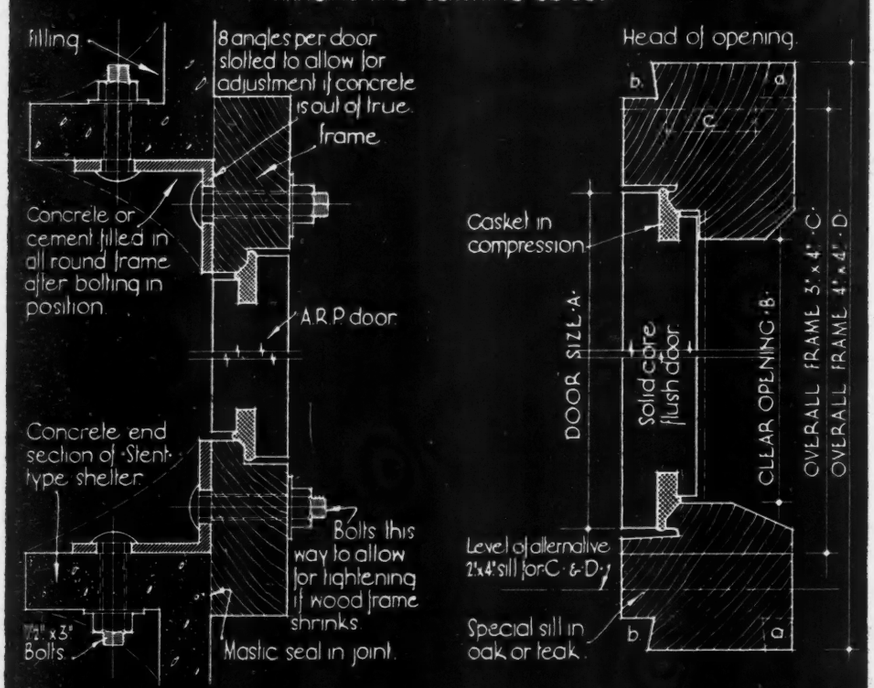
PRO. PAT. No. 11344/38.



SECTIONS SHOWING APPLICATION AND TYPICAL CONSTRUCTIONAL DETAILS OF THE DOOR AND FRAME.



PLAN THROUGH DOOR SHOWING STANDARD DOOR FRAME AND TREATMENT OF THE HANGING AND CLASHING EDGES.


Filling
8 angles per door slotted to allow for adjustment if concrete is out of true.
Frame
Concrete or cement filled in all round frame after bolting in position.
A.R.P. door
Concrete end section of 'Stent' type shelter
Bolts this way to allow for tightening if wood frame shrinks.
Mastic seal in joint.
Head of opening.
Gasket in compression
DOOR SIZE 'A'
Solid core flush door
CLEAR OPENING 'B'
OVERALL FRAME 3" x 4" 'C'
OVERALL FRAME 4" x 4" 'D'
Level of alternative 2"x4" sill for 'C' & 'D'
Special sill in oak or teak

VERTICAL SECTION THROUGH UNIT TYPE OF FRAME FOR USE ON FACE OF WALL.

VERTICAL SECTION THROUGH DOOR SHOWING SPECIAL SHAPED HEAD & SILL

DIMENSIONS SHOWING STANDARD DIFFERENCES

Size of door	'A'	As required, eg 6'6" x 2'6"	•
Size of clear opening	'B'	Deduct from size of door 1½" 1¾"	6' 4½" x 2' 4¼"
Size over 3" x 4" frames.	'C'	Add to size of door 2½" 3⅞"	6' 8½" x 2' 9⅞"
Size over 4" x 4" frames.	'D'	Add to size of door 5½" 5⅞"	6' 11½" x 2' 11⅞"
Size over 3" x 4" frames with alternative 2" x 4" sill.	•	Add to height of 'C' ¾"	6' 9¼" x 2' 9⅞"
Size over 4" x 4" frames with alternative 2" x 4" sill.	•	Deduct from height of 'D' 1⅜"	6' 10⅛" x 2' 11⅞"

NOTE: Rebate for plastic seal or grouting can be provided at 'a' 'b' or 'c'

SPECIFICATION

Core. Solid framed and laminated of Canadian Western Red Cedar, to usual fire-resisting requirements.

Gasket. Continuous band of ⅜" x 1" Dunlopillo, covered with gasproof rubberised linen.

Fastenings. Heavy refrigerator type.

Extras. Thermite-proof panel or steel-sheet fitted to face. Gas-proof observation panel of double reinforced glass bedded in rubber. Size 6" x 6". Heavy gauge hinges "Collinge" type.

•

THIS DOOR can be supplied in small sizes for shelters and refuges, or in standard sizes for use in administrative buildings, hospitals, power houses, offices, etc., as well as in flats and dwelling-houses.

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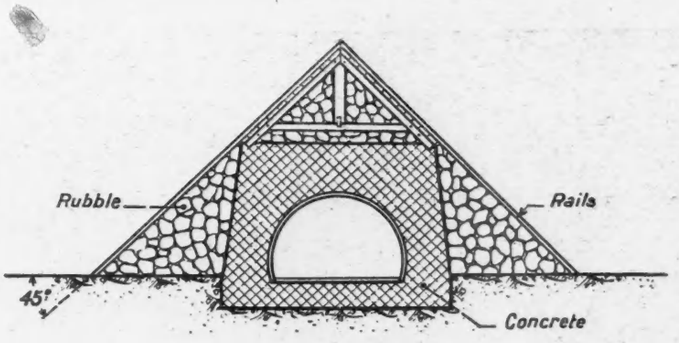
AIR RAID SHELTERS IN FRANCE

By JEAN W. PARTRIDGE
(Inspector-General of Public Works in Paris*)

It is possible and even easy to build shelters that will be proof against any kind or size of bomb, but in France, as everywhere, room, time and money would without any doubt be wanting to provide the population of the cities with so complete a protection against air raids.

So one must expect to find in use many kinds of shelters affording various degrees of protection. Shelters can give complete or comparative safety against gas and high-explosive bombs. They can be proof against direct hits or only against splinters and the blast of the exploding bomb. In every single case the degree of protection must be adequate to the needs. In France complete protection against bombs of at least 1 ton, with even some comfort, is considered to be necessary for headquarters, where the authorities in charge of air raid precautions will spend many hours, and vital telephone exchanges are also housed in such " bomb-proof " shelters.

* In a paper read before Air Raid Protection Institute.



Surface shelter with slanting roof.

FIG. 1.

Large Shelters.

Large shelters accommodating 1,000 people or more are also absolutely bomb-proof. The probability of a direct hit on such a shelter is naturally increased, owing to its size, and the consequences of the explosion of a bomb inside are too serious. Smaller shelters are usually proof against smaller bombs only, but, even for shelters accommodating 30 to 50 people, protection against a 110-lb. bomb falling on the roof is considered to be a minimum. It has been decided that all shelters must afford at least protection against splinters, and, when they are situated under or near a building, that they must also be able to withstand the fall of débris on top.

Instead of withstanding the impact of the bomb, it is possible to deflect it from a strong and slanting roof (45 deg., or even 60 deg.), or else to cause the bomb to explode before it can penetrate the shelter (Fig. 1). These devices are undoubtedly helpful, but, their action being uncertain and depending in a large measure on the type of fuse used on the bomb, the thickness of the roof slab of the shelter may not be much decreased, so that they are very seldom used. But if detonating slabs are seldom built over a shelter, shelters are, of course, frequently built as basements, so that the floors above act as burster slabs. But in any case the shelter proper must be very strongly built. In France the thickness of the roof to withstand the impact and explosion of a 110-lb. bomb is held to be: 2 ft. 4 in. of reinforced concrete; 3 ft. 3 in. of concrete; 4 ft. 11 in. of masonry; or 16 ft. 5 in. of earth.

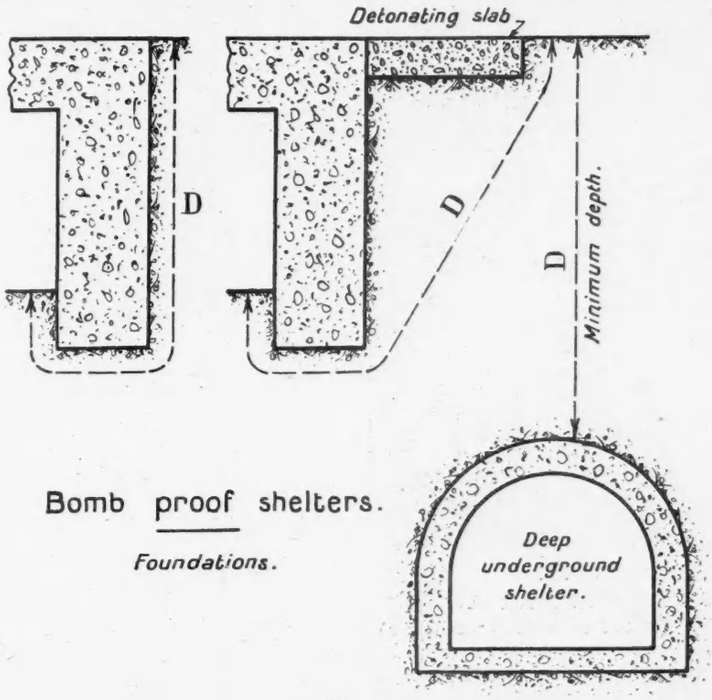
The size of the bomb that can be stopped increases much faster than the thickness of the roof, so that to resist the impact and explosion of a 1-ton bomb the thickness is only 6 ft. 7 in. of reinforced concrete; 9 ft. 10 in. of concrete; 19 ft. 8 in. of masonry; and 65 ft. 7 in. of earth.

These thicknesses are good only when applied in compact layers; it would, for instance, be wrong to add the resistance of a slab of concrete and the resistance of an overlaid layer of earth. This layer may, on the contrary, act like a wadding to increase the effect of the explosion on the slab and so be more harmful than useful. For the same reason the side walls of an underground shelter must be stronger than the roof slab itself and be 25 per cent. thicker.

A bomb falling close to a shelter can wreak damage below the floor of the shelter. It is deemed necessary, therefore, to make the floor very strong, half as thick as the roof, or to extend the walls to a great depth, and sometimes also to build a strong and wide detonating slab all round the shelter (Fig. 2).

Strengthening of Basements.

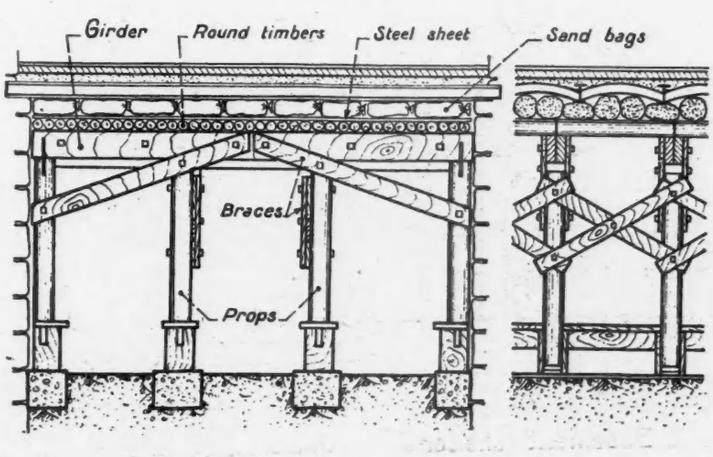
This mode of construction is the only one recognised in France as giving absolute protection against bombs of a given size. For protection against splinters and the fall of debris, a vault or basement will be sufficient, provided that its roof is strong enough to support the weight and impact of the house above. In such a location the shelter will give much better protection. Although exact computations cannot well be made, it is considered that the basements of three-storey houses, when the floors are shored up, will be proof against 110-lb. bombs. In Paris most houses are seven or eight storeys high, and their basements, whose ceilings are thick masonry arches or have been reinforced, are considered to be safe enough to shelter the population.



Bomb proof shelters.

Foundations.

FIG. 2.



Shored up basement shelter.

FIG. 3.

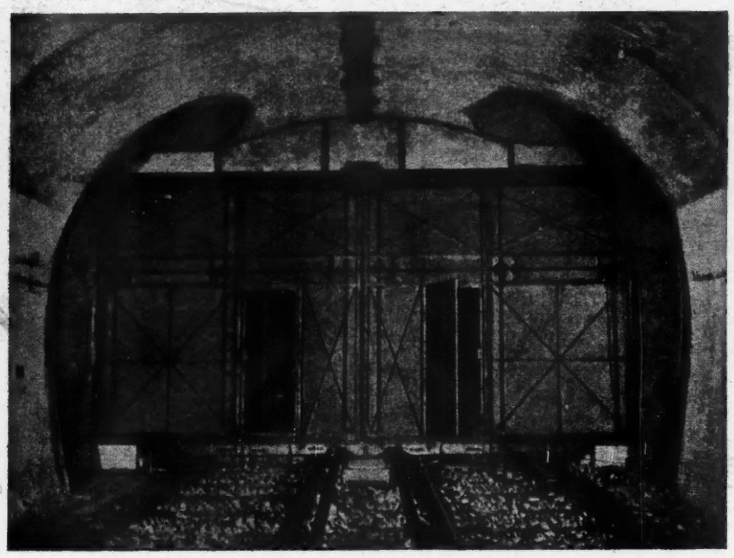


Fig. 4. SLIDING DOOR IN PARIS UNDERGROUND.

There is no exact rule for computing the pressure upon the basement roof caused by the fall of the upper storeys. For an eight-storey house, it is held to be equivalent to a static load of from 5 to 8½ lb. per sq. in., according to the mode of construction and to the character of the occupancy. In Paris this static load is fixed at 7 lb. per sq. in. It can be borne by a wooden prop 7 in. in diameter for 11 sq. ft. of roof surface, the resistance of the roof itself being set at nought. Props are carefully braced both ways with cross beams, to prevent their upsetting (see Fig. 3). Sectional steel and reinforced concrete props are held to be better than wooden ones, as they do not increase the risk from fire, and wear better, but they are not so easily put up. The props support girders and rafters, and above this timbering a strong corrugated steel sheet. The space between this sheet and the roof is filled with sandbags to distribute the load.

If the house is less than three storeys high, the added protection is of less value than the added risk from falling debris, so that it is better, if an open space is available, to build a shelter or dig trenches well away from buildings.

Trenches.

Air raid trenches in France are 2 ft. 8 in. wide and 5 ft. 11 in. deep, the excavated earth being heaped on both sides to a height of 1 ft. 8 in.

If the trench is to be left open, it is dug in a zigzag line, with not more than 14 ft. in a straight line, and will accommodate one person for every 1 ft. 8 in. of length. It is recommended to provide the trenches with an overhead cover made of round timber, planks, boards of sheet-steel, and heap over it the excavated material. In that case the trench may be wider and will measure 6 ft. at the top and 4 ft. at the bottom, and may be dug straight with traverses every 20 ft. It can then accommodate two rows of people—that is, two persons for every 1 ft. 8 in. of length. Stairs are provided at intervals of 10 to 20 yards, for accessibility.

The trenches must be revetted as soon as possible to prevent the walls caving in, and provided with lath grids, drains and soak-aways and with benches, so that people may sit down.

All shelters, other than trenches, have many common characteristics. They must be accessible, and the width of the stairs leading down to a shelter housing 150 persons must be at least 4 ft. An emergency exit is always provided, and one of the exits must be within easy reach of the street. The sewers of Paris are of large size, and it is easy to walk along in them. The sewer is connected to the house basement by a short gallery closed by a thin masonry wall through which pass the water, waste and telephone services. A safe connection is often established between the shelter and this gallery, so that people trapped in the shelter may escape or be rescued through the sewers by breaking down this wall—a matter of a few minutes (see Fig. 6).

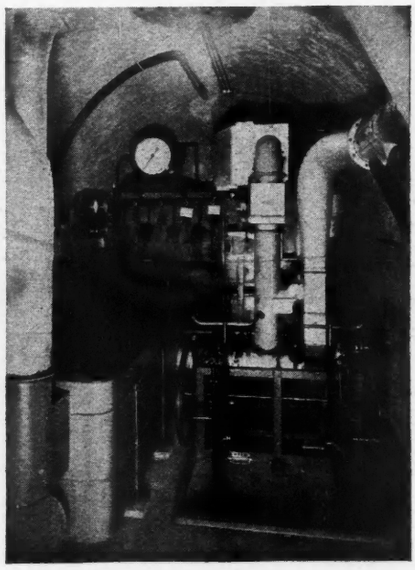


FIG. 5.
A VENTILATING AND AIR-FILTRATION PLANT. (Note Bicycle Emergency Drive.)

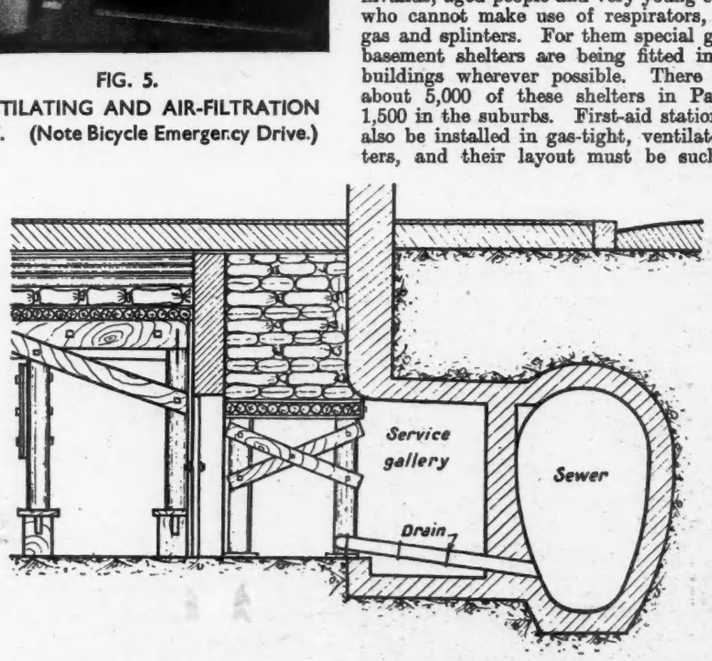
Most gas-tight shelters are provided with a system of ventilation sucking outside air through two separate pipes. This air passes through a coarse filter to eliminate dust, then through a special filter to eliminate all traces of gas. If the shelter is absolutely air-tight, or nearly so, used air is released through a valve adjusted to a pressure of 5 mm. of water. The ventilator is coupled direct to an electric motor and can also be driven by hand or foot operation as a stand-by in case the current should fail ((see Fig. 5).

Use of Underground Railway.

Although basement shelters and trenches are the normal means of protection for the civilian population, large public shelters have also to be specially built where crowds are likely to gather, as, for instance, near railway stations, big markets and business districts, or where no safe basements or no room for trenches are to be found. Such shelters are absolutely bomb- and gas-proof, for the risk of having a bomb explode in a shelter housing several hundred or thousand people is too great to be run. They are, of course, few in numbers.

Special mention must be made of the use of underground railway tunnels as shelters. When the top of the tunnel is 25 to 60 ft. underground, depending on the nature of the ground, it is bomb-proof and can be converted into a perfect shelter by making it gas-tight and providing easy access. Such a shelter has been made in the Paris Underground at the Station Place des Fêtes to hold 8,000 people. Overhead is a strata of marl 70 ft. thick, giving 100 per cent. security. The tunnel can be closed on both sides by sliding doors, providing also emergency exits. Air is furnished by a ventilation and filtration plant at the rate of 10,000 cu. metres per hour. Air locks would slow down excessively the rate of entry of the public into the shelters. Six or seven sets of swinging doors are therefore placed along each of the corridors leading to the station, and, owing to the high pressure in the tunnel, they will effectively prevent the entry of gases (see Fig. 4).

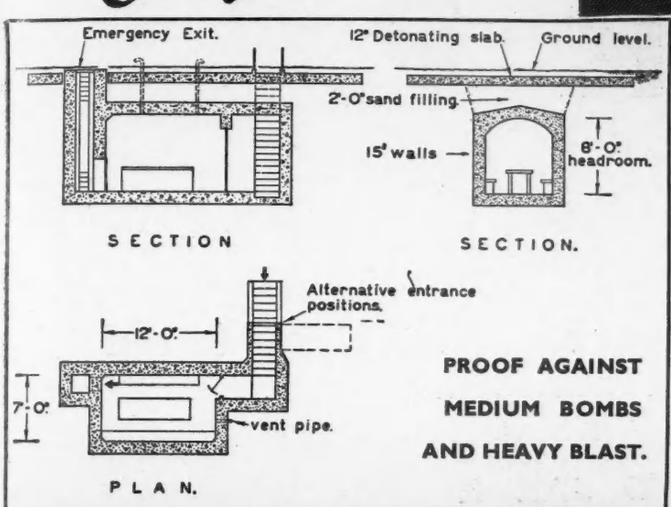
Special provision is being made to protect invalids, aged people and very young children, who cannot make use of respirators, against gas and splinters. For them special gas-tight basement shelters are being fitted in public buildings wherever possible. There will be about 5,000 of these shelters in Paris and 1,500 in the suburbs. First-aid stations must also be installed in gas-tight, ventilated shelters, and their layout must be such as to



Basement shelter - Communication with the sewer.

FIG. 6.

Unit Shelters



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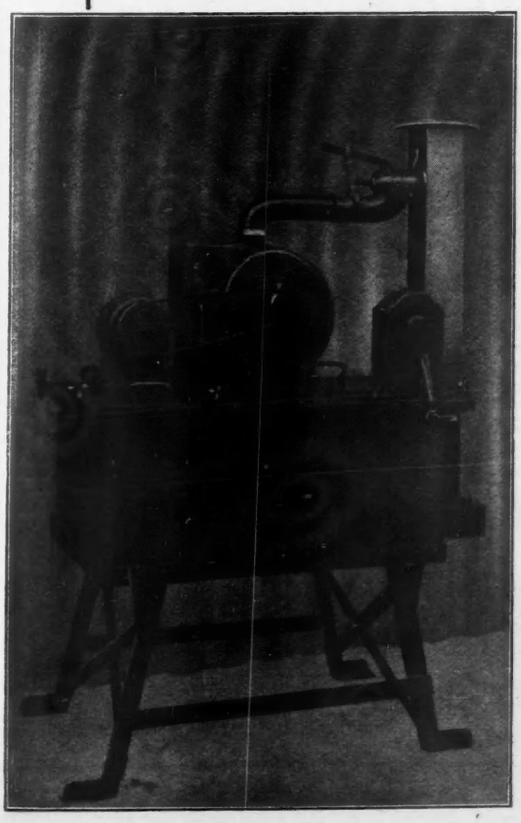

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accommodate wounded, burnt, suffocated, gassed and contaminated people.

A law of April, 1935, has made air raid precautions compulsory in France. This law provides for public bodies and private persons to bear the cost of the shelters they need, while the State pays for the shelters necessary to its departments and for the public shelters.

Commercial and industrial concerns with more than 100, 200 or 500 people, as the case may be, banks, plants making armaments, and those who have been specially ordered to do so, must build shelters at their own cost. Nothing could be done by the authorities in private houses, but a new law dated November 12, 1938, enables the Mayor to prescribe, even in private houses, that basements shall be consolidated, partitioned and connected with adjacent basements, and that materials for consolidation shall be stocked in basement rooms.

AN OVERGROUND PUBLIC SHELTER

In our Supplement No. 3 (included with our issue for March 24), we illustrated a design for an "overground bomb-proof air raid public shelter" by Mr. H. Charles Erith, M.I.Mech.E., with Messrs. Bertram S. Hume and Raymond C. Erith, AA.R.I.B.A., as consulting architects. We have now received some further drawings of the scheme, showing certain changes in the design, chief of which is the addition of space for surrounding terraces of flats, with or without shops and garages on the ground level.

In the course of an accompanying letter, Mr. H. Charles Erith writes as follows: "I have pleasure in enclosing prints of my recent design for an overground bomb-proof shelter for 5,000 people, involving no excavation whatever, and costing only £25,000, viz., £5 per head. As the perspective drawing shows, the 2½-acre site permits the addition of 48 good shops (or garage accommodation for 400 motor-cars, all on ground level), with 96 good flats above, and as the top of the one-acre mound is used as a communal playground, this feature is very attractive to tenants; and in cases where the site involves the temporary displacement of say, 50 small houses with 250 people, double that number can be rehoused on the same site in the 96 flats; and as the cost of the shops tnd flats will be roughly £80,000, and the net rental value about £8,000, such buildings will be very attractive for building societies, as the work can be started anv time after the bomb-proof shelter is finished; and the £25,000 shelter can easily be completed in a single month from the date that the site is available.

"The 5,000 people on a 50-acre site can all reach the shelter within two minutes; there are four entrance-exits each 11 ft. wide, and the whole interior is electrically lit, and efficiently ventilated on the plenum system; and the working cost for the Diesel-electric set, for both lighting and power, is only 9d. per hour; a storage tank for one ton of Diesel oil is provided.

"This overground shelter includes four first-aid rooms, close to the four entrances: a kitchen, a store-room, besides the power-room and the control room, with telephone exchange, for the responsible warden in charge.

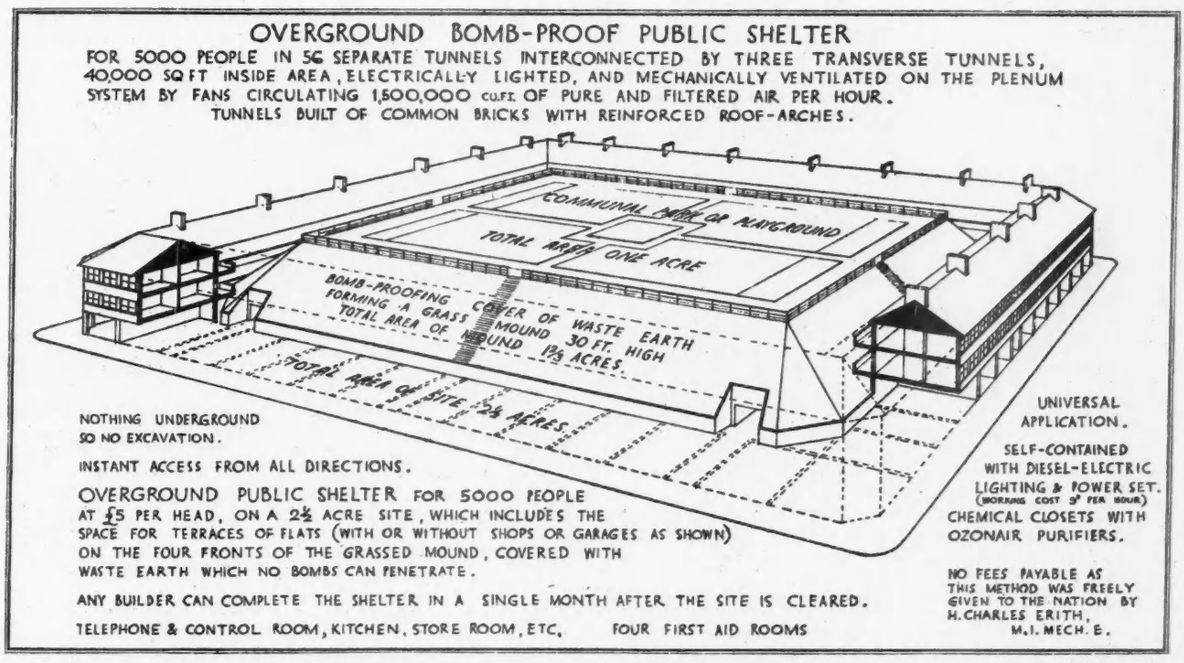
"Experience in Spain, where similar overground shelters were bored into hillsides from the ground level, and thus having the bomb-proofing earth cover already existing, showed that it is vital to have a warden in charge of every public shelter, and also to instruct the public which shelter to make for; these features assured the absence of confusion or panic.

"While the overground shelter can easily be designed in smaller units than the one for 5,000 persons which is shown on my plans, as, for instance, when the site available is less than 2½ acres, or when the shelter is for the exclusive use of employees in a factory employing less than 5,000 workers, experience has shown that the unit size of 5,000 people resident in an area of 50 acres is excellent when they can all get safely inside within two minutes and remain on the ground level in safety and comfort until the raiders have passed, under the control of a single warden.

"Experience in Spain showed that units for 1,000 to 3,000 were suitable where the shelter tunnels were 10 to 15 metres (viz., 33 ft. to 50 ft.) below the ground level, as this involved slow access by long staircases; but in the overground shelter, with no staircases at all, access is very quick and easy, as it was with the hillside shelters in Spain, and as it is in the shelters for 10,000 workers of Austin Motors, Ltd., at Longbridge Works at Birmingham, where the tunnels are bored under an existing mound and thus no stairs were needed; in the latter case the total cost was only £25,000, viz., £2 10s. per head; and there is no objection to sheltering 10,000 people in such cases, where they can all be safe in two minutes.

"In my original plan of the overground shelter [*The Builder*, March 24] the bomb-proofing cover was shown as 50-ft. thick, viz., 15 metres, to correspond to the thickest earth cover used in Spain; but experience has proved that no aerial bombs make deep craters, and that the 20-ft. of solid earth cover shown in my present plans is ample. The 30-ft. mound of the 5,000 persons overground shelter corresponds to 50,000 cubic yards or 50,000 tons of waste clay or other earth, which can be loaded into dumper-lorries at brickyards for only 2½d. per ton, say £500; the haulage cost varies with the distance; the piling is done exactly as for piling sugar-beets, using portable belt-conveyors in pairs, working in tandem; or alternatively, trestles and a single conveyor can be used, or tip-wagons hauled by an oil-loco; in all cases, the piling is very rapidly done, just as if building a railway embankment or a water-reservoir, and the slopes of the mound are grassed over, while the top is fenced in as a communal park or playground, as shown.

"No rights whatever are reserved, as I have freely communicated plans and full information of the overground shelters not only to the British Government and to our allies, but also to builders, to local authorities, and to the public generally, including numerous patriotic employers who are arranging to protect their workers at their own cost, although it is a well-known fact that all other weapons of national defence are paid for by the taxpayers, including the identical method of bomb-proofing by a mound of earth for property in the shape of petrol and other munitions of war. It is difficult, therefore, to imagine why local authorities, employers


OVERGROUND BOMB-PROOF PUBLIC SHELTER
FOR 5000 PEOPLE IN 50 SEPARATE TUNNELS INTERCONNECTED BY THREE TRANSVERSE TUNNELS, 40,000 SQ FT INSIDE AREA, ELECTRICALLY LIGHTED, AND MECHANICALLY VENTILATED ON THE PLENUM SYSTEM BY FANS CIRCULATING 1,500,000 CU.FT. OF PURE AND FILTERED AIR PER HOUR.
TUNNELS BUILT OF COMMON BRICKS WITH REINFORCED ROOF-ARCHES.
COMMUNAL PARK OR PLAYGROUND
TOTAL AREA ONE ACRE
BOMB-PROOFING COVER OF WASTE EARTH FORMING A GRASS MOUND 30 FT. HIGH
TOTAL AREA OF MOUND 12½ ACRES.
TOTAL AREA OF SITE 2½ ACRES.
NOTHING UNDERGROUND SO NO EXCAVATION.
INSTANT ACCESS FROM ALL DIRECTIONS.
OVERGROUND PUBLIC SHELTER FOR 5000 PEOPLE AT £5 PER HEAD, ON A 2½ ACRE SITE, WHICH INCLUDES THE SPACE FOR TERRACES OF FLATS (WITH OR WITHOUT SHOPS OR GARAGES AS SHOWN) ON THE FOUR FRONTS OF THE GRASSED MOUND, COVERED WITH WASTE EARTH WHICH NO BOMBS CAN PENETRATE.
ANY BUILDER CAN COMPLETE THE SHELTER IN A SINGLE MONTH AFTER THE SITE IS CLEARED.
TELEPHONE & CONTROL ROOM, KITCHEN, STORE ROOM, ETC. FOUR FIRST AID ROOMS
UNIVERSAL APPLICATION.
SELF-CONTAINED WITH DIESEL-ELECTRIC LIGHTING & POWER SET. (WORKING COST 9D PER HOUR)
CHEMICAL CLOSETS WITH OZONAIR PURIFIERS.
NO FEES PAYABLE AS THIS METHOD WAS FREELY GIVEN TO THE NATION BY H. CHARLES ERITH, M.I. MECH. E.

OVERGROUND BOMB-PROOF PUBLIC SHELTER: DIAGRAM SHOWING RELATION OF SIZE OF EACH SHELTER TO AREA SERVED BY IT.

AREA OF SITE OF SHELTER = 2½ ACRES.
NUMBER OF PERSONS DISPLACED = 250.
NUMBER OF PERSONS ACCOMMODATED = 5,000.
AREA SERVED BY EACH SHELTER AT THE RATE OF 250 PERSONS TO 2½ ACRES = 50 ACRES.
50 ACRES = 2,178,000 SQ. FT., OR THE AREA OF A RECTANGLE, 1,524 FT. × 1,434 FT.
DISTANCE FROM EXTREME BOUNDARY OF AREA SERVED BY EACH SHELTER TO SHELTER ITSELF = 572 FT. = 191 YDS.
LENGTH OF WARNING REQUIRED BY PERSONS ON EXTREME BOUNDARY OF AREA SERVED BY SHELTER, APPROX. 2 MINUTES.

and individual citizens should be burdened with the provision and expense of this vital weapon for saving human life, which is most urgently needed in the target areas for bombing invaders, viz., the riverside and dockside areas where our war-workers are densely housed, but where the overground shelters could be completed very rapidly and cheaply and evacuation thus avoided, except for the schoolchildren and non-workers who should be evacuated to ease food supply.

"In these riverside areas, it will generally be nesessary to provide a concrete raft to carry the shelter on a wet soil; but this only adds about £1 per head to the £5 for the overground shelter as built on solid ground, as in public parks, squares, and other open spaces on chalk or other solid soils. As there is no excavation, there can be no flooding risk.

"The shelter problem has been enormously simplified since it became generally known that no-one has ever been gassed by gas bombs from a flying aeroplane; it is easy to make a dangerous concentration of poison gas by bombs from a stationary gun or mortar, and therefore a soldier has a gas-mask; but it is impossible for gas bombs, dropped from a great height by flying aeroplanes, to effect a dangerous concentration of poison gas; and therefore anti-gas provisions are no longer proposed for shelters of any kind by the British Government.

"In the same way, there is no analogy whatever between the costly fortress-construction such as the Maginot or the Siegfried lines, which have to resist the concentrated fire of heavy artillery from stationary guns, and the cheap bomb-proofing by a cover of waste earth, which totally defeats aerial bombing when human life is thus protected. Aerial bombs are dropped in great numbers, but indiscriminately and from a great height; there is nothing like the concentrated shelling from stationary guns to contend with, and the craters made are very shallow; the aerial bombs destroy buildings and kill people mainly by the effect of horizontal blast over a wide radius per bomb, as direct hits are necessarily rare; but no case is known of an aerial bomb in actual warfare penetrating a shelter covered by 20-ft. of earth, and thus it would be folly to waste time and money on shelters costing more than the £5 per head which is assured with the overground bomb-proof shelter now illustrated."

CORRESPONDENCE

[While we are glad to publish letters on professional and other matters of interest to our readers, it must be understood that we do not necessarily endorse the remarks of correspondents, who will oblige us if they will express their views as briefly as possible.]

Air Raid Precautions: Experience in Spain.

TO THE EDITOR OF *The Builder*

SIR,—As a construction engineer who has spent the last ten years in Spain, two years being in Palma Mallorca, Franco's naval base during the civil war, I may claim to have had first-hand experience of structural A.R.P. under war conditions. I was appointed one of the chief technical air-raid wardens, was militarised, and worked in conjunction with Spanish, German and Italian experts. Without fear of contradiction we made Palma the safest city in Europe for the civil population. In two years, from a state of panic, when factories, shops, gas and electricity works closed down, as the civil population and workpeople fled to the country and mountains, we arrived at perfect calm, with all classes of business carried on as usual. During the last air raid I was in, 17 tons of high-explosive bombs were dropped in the centre of a congested, narrow-streeted town, and although only four minutes' warning was given, nobody was killed or injured. Many buildings were destroyed from direct hits and shock, ten horses were killed, and several cars destroyed, yet the population was safe in deep, well-constructed shelters. The population of Palma was 120,000 people.

I was in more than 50 actual air raids, and we learnt by experience; we held an "inquest" on every bomb that was dropped in sizes ranging from one ton to 50 lb. in weight. The 100-lb. and 250-lb. bombs which exploded on contact were the most prevalent used by the late Government, also by the Nationalists. The greater number of these dropped from 20,000 to 30,000 ft. did more damage than one large one. We were well protected by anti-aircraft guns, modern aeroplanes and German, Spanish and Italian battleships, which kept the invading planes so high that the town and civil population was the only objective. Therefore the military orders were "Condemn every blast- and splinter-proof shelter, and give the most absolute protection from direct hits for bombs of 250 lb."

Wherever possible, we built deep underground shelters at most of the street corners; they were chiefly in the form of tunnels running under the houses or paved streets; we never built them in the parks or open country. A 100-kilo bomb dropped on a paved street, say, of concrete, tarmac or asphalt, would explode on contact and make a hole only a few feet deep. It certainly destroyed buildings with blast and shock, but never reached the shelters. If dropped on to soft ground, such as gardens and fields, these bombs would make holes big enough to bury tramcars. Therefore we used the streets or buildings as exploding mats, and by connecting up the tunnels we always had several safe exits for all who were in the shelters.

Cellar protection in practically all cases was condemned after the first year of warfare. Nobody who has had the actual experience of getting people out of cellars when the buildings have been destroyed over them would recommend them; 48 hours to one week to clear the wreckage is normal practice, and although the people are often safe when taken out, the shock effects are terrible. In my opinion, lining with steel the average English cellar where so much wood goes into the construction of the buildings would make them about as safe as sitting in the kitchen oven.

I said we held an "inquest" on every bomb which was dropped; we also carried out our own tests. For instance, down at the port where the Mediterranean sea is at constant level, we built above-ground shelters so that the loading and unloading of the ships could go on almost uninterrupted. We built one shelter, the walls of which were one yard thick of 5 to 1 concrete, reinforced with tram-rails, vertical and horizontal. When I told the chief of the naval base of our experience in the Great War of people being killed only by shock we tested this one. We exploded a 100-kilo bomb one yard away from the shelter. The twenty sheep we put inside to prove the test were all killed by shock, transferred through the hard reinforced concrete, although the shelter itself was only slightly damaged. We exploded another on the roof concrete, which was separated from the structure by a sand-cushion about 1 ft. thick. Although this explosion mat was badly damaged, the sheep inside the building were all uninjured. So shelters above ground were constructed in sandwiches of concrete and sand. Wherever possible, although the engineering difficulties were many—very often water—we built them, as I said before, 20 to 30 feet underground, with many "staggered" entrances, using as our material concrete, brick, or sandstone.

This I know—with a population which started in panic, though often hungry, developed a high *morale*, which led to victory, because of well-constructed, deep, underground shelters, but not at £2 per head.

HENRY FIRBANK, M.Inst.H.E.

THE USES OF PLYWOOD FOR A.R.P.

THE adaptability of plywood for the purposes of air raid precautions rests primarily on the fact that it is a rigid material available in large surfaces. In its simple form one can say that in its direct application to A.R.P. its use is limited to the construction of shutters for windows as a convenient protection against the effect of remote blast.

In Spain a familiar sight on windows was that of crossed strips of gummed tape intending to act as a cohesive. Plywood for shuttering was, however, established as being superior in resisting air disturbance, and the authorities in this country have accepted that plywood shuttering is a satisfactory protection for windows outside the range of direct blast.

It is, however, in its composite forms that plywood has proved most useful for A.R.P. The two primary uses of composite plywood products are, firstly, for the construction of decontamination centres and first-aid stations; and secondly, for localising and isolating the effects of incendiary bombs.

For decontamination stations it is essential that, as far as possible, the walls "should be finished with smooth-faced impervious material which can be washed and decontaminated." (A.R.P. Handbook No. 1.) Metal-faced plywood has the advantages that it cannot be dented and can be used for constructional work without any difficulty in fixing. It can be worked like wood and with the same tools. Half-inch plywood faced with 28 gauge galvanised steel each side can be used to line the walls of any ground-floor room, having good ingress and egress, in a very short space of time, by using stock-sized sheets size 72 in. by 30 in., which is the height recommended in the A.R.P. Handbook. Metal-faced plywood used in this way can be hosed down repeatedly without damage or deterioration. If necessary, floors and ceilings can be lined with this material. The panels can be rendered waterproof by the sealing of all edges.

The decontamination station itself can be partitioned by the use of metal-faced plywood into as many sections as considered desirable. A special use for which either the $\frac{3}{8}$ in or $\frac{1}{2}$ in. material is adapted is for lavatories. Its advantage for this purpose is that the cubicles can be purchased in standard units from leading manufacturers and can be rapidly assembled wherever appropriate. Builders of evacuation camps, which in time of war may conceivably have to be migratory should the enemy decide that they offer good targets, will find that easily assembled metal-faced plywood cubicles are particularly well adapted to their needs.

As protection against incendiary bombs, various forms of composite plywood boards have been evolved, but plywood faced with asbestos, together with certain forms of metal-faced plywood, are suitable. Tests made with an incendiary bomb burning at 3,000 deg. Centigrade have established that although the asbestos will be charred locally, the reverse side of the plywood will remain unscathed. A fire-resistant board of this kind is a desirable protection for the suburban type of house, where an incendiary bomb falling through the rafters is likely to ignite on an attic floor which can be reached only through a trap door. It is a wise precaution to line floors and rafters with a fire-resisting board, so that, in the event of a house surviving a direct hit, a bomb may burn itself out without communicating its effects to any other part.

In the case of large shelters it would no doubt be possible to combine the functional use of composite plywood products with their decorative value, so that the troglodyte existence we may have to face will have some ameliorating circumstances. For example, plywood faced with Bakelite veneers offers a hard, washable, non-inflammable surface whose attractiveness will be almost as apparent in conditions of emergency as it is in the easier conditions of civilian life. In

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Barcelona, many of the air-raid shelters were ornamented in order that the morale of the civilian population should not be shattered by the complete abstraction of the familiar things of civilian life. Plywood, which has in the past been associated chiefly with decorative veneers for the panelling of lounges and furniture, may still usefully retain some of its decorativeness when it is applied to the grimmer uses of air raid precautions.

MAURICE EDELMAN, B.A.(Cantab.).

A.R.P. SCHEMES

BIRMINGHAM.—Air raid shelters for 2,000 employees are to be made for the G.E.C. Magnet Works at the disused Midland Brick Works, Garrison-street.

BLACKPOOL.—A.R.P. Committee report that the Borough Engineer and Surveyor be instructed to prepare an amended scheme for three decontamination stations.

BRIGHTON. — A.R.P. Committee have approved the provision of a laundry for decontamination at the Hollingdean Depot, at an estimated cost of £1,050, and have also approved a scheme for the erection of a first-aid station in Lewes-road, at an estimated cost of £975.

BRISTOL.—C.C.'s A.R.P. plans include the erection of a £38,000 clinic at Southend Hospital, to be used as a casualty centre; and extension of the R.A.F. Volunteer Reserve Flying Centre at Bristol Airport.

CAMBERWELL.—Messrs. E. R. Watts and Son, Ltd., propose to lay out shelters for their employees at the rear of their premises in Camberwell-road.

CHELSEA.—B.C. are to provide permanent shelter trenches at Burton-court, Cadogan-gardens South and Paultons-square.

CHELSEA.—The B.C. has placed a contract with Messrs. J. A. Dumayne and Co., Ltd., 1, Browning-street, S.E.17, for structural and other works at the town hall.

CRAYFORD.—The Ministry of Health have approved in principle, subject to the submission of plans and estimates, the erection of cleansing stations at Crayford, Burnehurst and Slade Green.

CROYDON.—The A.R.P. Committee have approved plans for providing air raid shelter at the Town Hall, estimated to cost £2,000, and have directed the scheme to be submitted for approval and, subject thereto, for the work to be put in hand.

DARTFORD. — T.C. has approved that permission be granted to Messrs. Vickers-Armstrong, Ltd., to erect four large air raid shelters at Powder Mill-lane on land owned by the Corporation which is at present in lease to the Dartford Sand and Gravel Pits, Ltd.

DUDLEY.—T.C. proposes air raid shelters at Porter-street, King-street, and Netherton Market-place, for 3,000. Estimated cost, £30,000.

EALING.—The tenders of Messrs. Anti-Bomb Constructions, Ltd., 28, Victoria-street, S.W.1, and Messrs. Ammon Hirst, have been accepted by T.C. for completion of trenches.

EAST HAM.—The B.E. has submitted an estimate amounting to £24,070 for structural and other precautions at buildings to be used for casualty services.

EAST SUSSEX.—The C.C. have set aside the sum of £27,000 for A.R.P. work, including the sum of £15,000 for shelters and trenches, at 20 county schools.

ESSEX. — The C.C. has been asked to accept the following recommendations of the A.R.P. Committee: Erection of building for storage purposes, Hornchurch (£1,380); estimated cost of headquarters and main control, Chigwell (£6,300); adaptations in connection with various properties totalling £471.

FINSBURY.—It has been recommended that provision of an air raid shelter on the Busaco-street area be made at an estimated cost of £86,399. Messrs. Tecton, architects.

FULHAM.—The A.R.P. Committee recommend that an expenditure of £37,162 be authorised for the marking out of sites and the erection of the steel shelters now in course of delivery, and that the supplemental estimate submitted by the Finance Committee in the sum of £13,007, being the proportion of the expenditure to be borne by the Council, be approved.

GOSFORTH.—Erection of A.R.P. headquarters for the U.D.C. Clifford Wyld, surveyor. T. Finlay, Gosforth.

GREAT BRITAIN.—Work is soon to begin on the building of a network of hutment hospitals throughout the country for use in a national emergency. The hospitals will be built of wood. As a beginning, two groups have been decided on for Manchester, one at Baguley to hold 300 patients and another at Langho, near Clitheroe, to hold 200.

HAILSHAM.—The R.D.C. have approved a scheme to extend the present A.R.P. headquarters, to include an A.R.P. report centre and have directed that the plans of the scheme, estimated to cost £5,000, should be submitted to the Home Office.

HAYES AND HARLINGTON. — U.D.C. has instructed the engineer and surveyor to prepare specifications and invite tenders for a cleansing station at Minet-drive depot and a clothing decontamination building.

HEBBURN-ON-TYNE.—The U.D.C. Surveyor, Mr. E. G. Lediard, is to prepare plan for air raid shelters.

HENDON. — It has been recommended that the Borough Surveyor be instructed to prepare plans and estimates and advertise for tenders for the erection of three buildings for A.R.P. purposes and that application be made to the Minister of Health for sanction to the borrowing of £29,000. Plans and estimates for the construction of trenches to accommodate up to 10 per cent. of the population of the borough have been forwarded to the Home Office.

HETTON-LE-HOLE. — U.D.C. Surveyor (Mr. C. E. Butterworth) to prepare scheme for splinter-proof shelter for the Rainton Bridge Infectious Diseases Hospital.

ISLINGTON. — The A.R.P. Committee seek approval of a scheme for the provision of public air raid shelter at the premises of the North London Drapery Stores, Seven Sisters-road, at an estimated cost of £16,090.

JARROW-ON-TYNE. — T.C. is recommended to provide A.R.P. shelters in five areas to accommodate 2,100 people.

KENSINGTON. — The tender of Messrs. J. P. Williams, Ltd., amounting to £525 has been accepted by the B.C. for the strutting and strengthening of a basement at the Town Hall for A.R.P. purposes. The total cost of the scheme is £1,100.

KENT.—With regard to provision for air raid protection in schools, the A.R.P. Committee of the C.C. recommend that they be authorised to proceed with the work of providing protection for school children up to an expenditure not exceeding £75,000 for elementary education and £25,000 for higher education.

LANCASTER.—Mr. F. Hill, City Engineer, has prepared plans for construction of public air raid shelter, estimated cost £5,000.

LEWES. — The E.C. have recommended that 430 yds. of A.R.P. trenches be provided at an estimated cost of £1,600.

MIDDLESBROUGH. — T.C. is to spend £12,300 on the protection of the gas undertaking from air raids.

NEWCASTLE.—The Home Office has approved the scheme for the conversion of Victoria Tunnel into an A.R.P. shelter and has instructed the Watch (A.R.P.) Committee to proceed at once with the construction of 15 or 16 entrances to the tunnel. A revised scheme, estimated to cost £6,126, for protecting and strengthening the report centres at the East End and West End Police Stations, the A.R.P. Headquarters and the Central Police Station was approved subject to the consent of the Home Office.

NEWCASTLE-ON-TYNE. — The C.C. intends to strengthen four A.R.P. headquarters, at a cost of £6,126, and to erect concrete shelters in all places where steel shelters are not suitable. Mr. Percy Parr, Town Hall, is the City Engineer.

NEWCASTLE-ON-TYNE. — The Watch Committee (A.R.P.) is to apply to the M.H. for sanction to borrow £28,100 for the construction of 15 entrances and the installation of a lighting system in connection with the conversion of the Victoria Tunnel into an air raid shelter.

OLD BROAD STREET.—Messrs. Samuel Montagu and Co. are to construct a reinforced concrete sub-basement to be used as an air raid shelter; the architects are Messrs. W. Curtis Green, R.A., Son and Lloyd and the contract has been placed with Messrs. Charles R. Price, of Bishopsgate and Stoke Newington.

POPLAR. — For providing blast- and splinter-proof accommodation at the Bow, Bromley, Northumberland Wharf and Millwall depots, the B.C. has approved £8,411. First-aid posts are to be established at St. Andrew's Hospital, Devons-road, and at Poplar Hospital, East India Dock-road, at £980. The Home Office has approved the plans of the works proposed at the Council's report centres at the Poplar Town Hall and the old Council Offices, at £1,791. A scheme has been prepared for the report centre on the Isle of Dogs, which provides for the adaptation of a portion of Messrs. Maconochie's premises.

POPLAR. — Messrs. W. Lusty and Sons, Ltd., Bromley-by-Bow, E.3, are proposing to provide trenches to accommodate 900 persons under their proposed new premises in Empson-street. The trenches will be available to the public.

PORTSMOUTH.—The T.C. has approved the following schemes: Construction of 14-in. brick wall to form blast-screen at St. Mary's Hospital, £130; underground operating theatre, £700; conversion of eight houses as first-aid posts; construction of trenches in schools, £2,375.

ROTHERHAM.—T.C. is to erect decontamination buildings at the Highways Depot.

ST. PANCRAS.—It has been recommended to the B.C. that application be made to the Home Office for grant towards the cost of construction of the basement portion of the new offices in Pratt-street to provide an air raid shelter.

SHEFFIELD.—587 basements have been inspected for shelter accommodation and detailed surveys of 40 basements have been made. All basements to be used for shelter purposes will be strengthened and made gas-proof. Mr. R. Nicholas is the City Engineer.

SOUTH SHIELDS.—T.C. is to provide 24 A.R.P. wardens' posts throughout the town, costing from £50 to £75 each.

STOKE NEWINGTON.—The B.C. are to ask the Home Office to approve in principle a scheme for air raid shelters to cost £500,000. The scheme provides for deep shelters, principally in the form of tunnels.

SUNDERLAND.—The A.R.P. Committee estimate that 22,310 concrete shelters will be needed, at a cost of £345,805.

SUNDERLAND. — The Finance Committee have approved the spending of £2,600 on A.R.P. cleansing stations. The Corporation are considering a scheme to construct covered-in trenches for 11,000 people with reinforced concrete linings and coverings. Mr. J. E. Lewis is B.E.

TUTBURY.—The R.D.C. have approved plans for 20 underground air raid shelters to house the employees of Pirelli's, Ltd., Stretton.

WANDSWORTH. — The A.R.P. have approved a report of the Acting Borough Engineer in respect of alterations to be carried out at the public baths for air raid purposes, at an estimated cost of £2,955. The tender of Messrs. Girlings Ferrocrete Co., at £2,902 has been accepted for trench linings in King George's Park. It has been recommended that the following tenders be accepted: Messrs. J. Smithers—excavating and lining trenches, Garratt Green, Wandsworth Common and Clapham Common (two sites), at £1,154, £2,809, £1,215, and £1,846 respectively; Messrs. Constable, Hart and Co.—excavating and lining trenches, Tooting-gardens and Tooting Graveney Common, at £1,098 and £1,079 respectively; Messrs. Galbraith Bros., Ltd.—excavating and lining trenches, Streatham Vale Park, Streatham Common North and Streatham Common South, at £1,372, £1,392, and £1,403 respectively; Messrs. London Concrete Construction Co.—excavating and lining trenches, Tooting Bec Common, £4,110. It has been recommended that the contract of Messrs. E. H. Burgess, Ltd., be extended to cover the installation of the trench linings supplied by Messrs. Girlings Ferrocrete Co., for the trenches in King George's Park. The Acting Borough Engineer has submitted proposals for the protection of buildings at Putney Vale, Wandsworth, Streatham, and Putney Lower Common Cemeteries, at a cost of £850, and also proposals for protection of the public libraries, at a cost of £2,185; it is recommended that the proposed works be proceeded with.

WOOD GREEN.—The B.C. has decided, subject to the approval of the Middlesex C.C and the Home Office, to provide permanent and temporary accommodation for a main A.R.P. report centre and control headquarters, at an estimated cost of £2,080.

"THE BUILDER"
GUIDE TO MATERIALS AND EQUIPMENT
FOR A.R.P.

ACCESS LADDERS.
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J. B. GRAVITY Ladder Co., Ltd.

ACTIVATED CARBON FOR POISON GAS PROTECTION.
SUTCLIFFE, Speakman & Co., Ltd.

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MESH Steel.
ROM River Co., Ltd.
"TWISTEEL" Reinforcement, Ltd.

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HIGGS & Hill, Ltd.
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STEEL Scaffolding Co., Ltd.

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BRABY, Fredk., & Co., Ltd.
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DEVERILL, John, Ltd.
ELLIS, JOHN, & SONS, LTD.
GIRLING'S FERRO-CONCRETE CO., LTD.
INDENTED BAR & CONCRETE ENGINEERING CO., LTD.
LIVERSEDGE Reinforced Con. Eng. Co., Ltd.
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STENT Precast Concrete, Ltd.
TRENT Concrete, Ltd.
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BRITISH Bitumen Emulsions, Ltd.
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EXCEL ASPHALTE CO., LTD.
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GRANGERSOL, Ltd.
JONES, Jno., (Steel-Crete), Ltd.
KERNER-Greenwood & Co., Ltd., "Pudlo."
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NICHOLLS & Clarke, Ltd.
PERMANITE, Ltd.
R.I.W. Protective Products Co., Ltd.
RIGBY (London), Ltd.
SAL Ferricite Constructions Ltd.
SEALOCRETE PRODUCTS, LTD.

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BOOTH, J., & SON (BOLTON), LTD.
BRABY, Fredk., & Co., Ltd.
BRITISH Plywood Mfrs., Ltd.
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HAYWARDS, LTD.
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DREW, CLARK & CO.

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KEITH-BLACKMAN, Ltd.

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ATTOC BLOCKS, LTD.
KING, J. A., & Co., Ltd.
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UNEEK CONSTRUCTIONS, LTD.

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AIR CONDITIONING CORPN. (JEFFREYS), LTD.

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CARRIER Engineering Co., Ltd.
GREENWOOD-AIRVAC: Greenwood's Ventilating Co., Ltd.
KEITH-BLACKMAN, Ltd.
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GREENWOOD-AIRVAC: Greenwood's Ventilating Co., Ltd.

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RONEO EQUIPMENT.
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TRENT Concrete, Ltd.
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WATES, Ltd.
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DURASTEEL Roofs, Ltd.
FRAZZI, Ltd.

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MILLS Scaffold, Ltd.
SCAFFOLDING (Great Britain), Ltd.
STEEL SCAFFOLDING CO., LTD.

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CELLACTITE & BRITISH URALITE, LTD.

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"BOSTIK" B.B. Chemical Co., Ltd.

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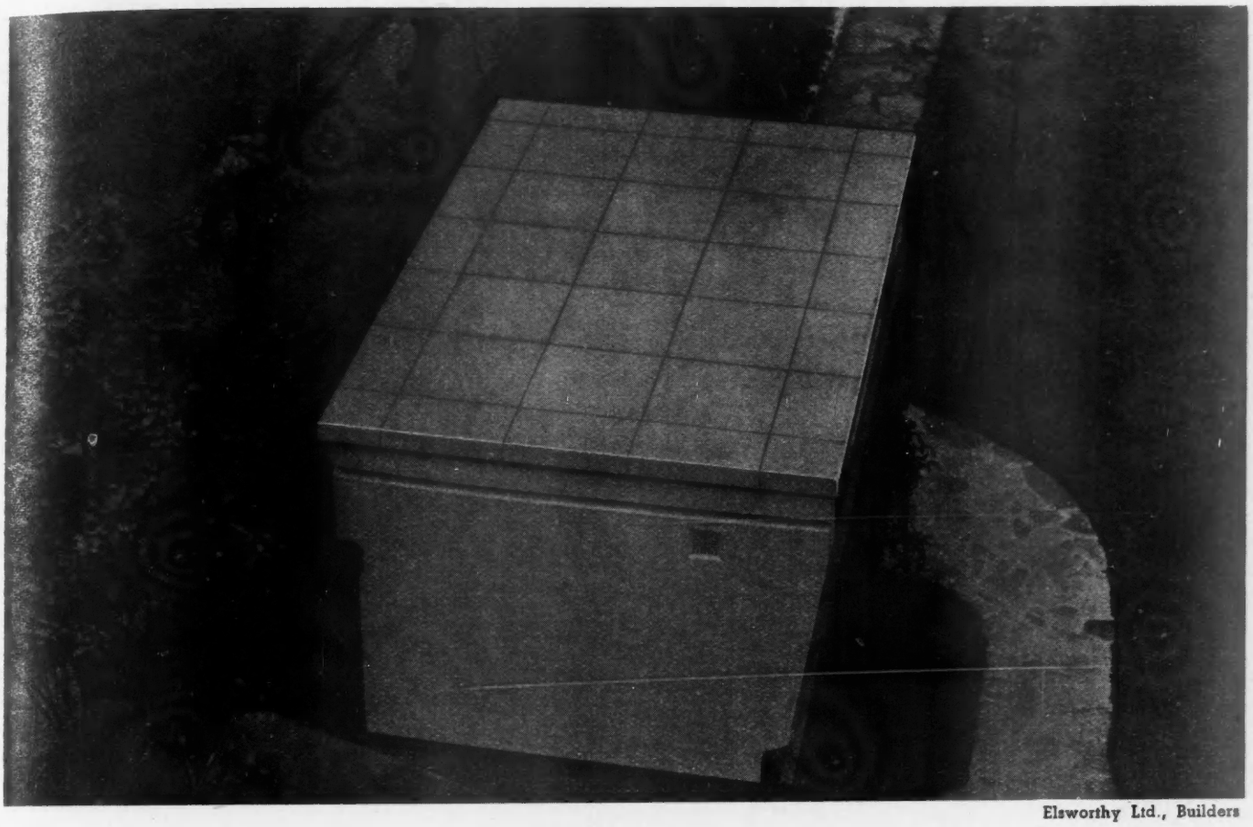
CROFT Granite Brick & Concrete Co.
DEVERILL, John, Ltd.
DUCTILE Steels, Ltd.
ELLIS, JOHN, & SONS, LTD.
GIRLING'S FERRO-CONCRETE CO., LTD.
LEWIS Construction.
LIVERSEDGE Reinforced Con. Eng. Co., Ltd.

FOR CONTINUATION OF THIS GUIDE, SEE PAGE xlii.



Elsworthy Ltd., Builders

A PAROPA ROOF

protects this Domestic Air Raid Shelter against Incendiary Bombs and Gas

This is a typical domestic Air Raid Shelter with the additional protection of a PAROPA Roof. For years PAROPA has been recognised as the most successful material for flat roofs, terraces and balconies — hard wearing, attractive and impervious to moisture. And now its particular qualities have been proved to be invaluable for A.R.P., as a final protection to the roof of shelters it renders them proof against incendiary destruction and the effects of gas.

It is important to remember that all roofs that look like PAROPA are not necessarily PAROPA. It is essential to specify "PAROPA laid by Frazzi Ltd."

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"THE BUILDER" GUIDE TO MATERIALS AND EQUIPMENT FOR A.R.P. —(continued)

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SCAFFOLDING (Great Britain), Ltd.
SELF-SENTERING EXPANDED METAL CO., LTD.
SHARP Jones & Co., Ltd.
SPUN Concrete Ltd.
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STEEL SCAFFOLDING CO., LTD.
STENT Precast Concrete, Ltd.
TRENT Concrete, Ltd.
TRIANCO, LTD.
TRUSSED CONCRETE STEEL CO., LTD.
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WATES, Ltd.
WEBSTER, Davidson & Co,, Ltd.
WESTWOOD, Jos., & Co., Ltd.
WILMOT, S. M., & CO., LTD.
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BURN Bros. (London), Ltd.
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ACROW (Engineers), Ltd.
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GREENWOOD-AIRVAC: Greenwood's Ventilating Co., Ltd.

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SELF-Sentering Expanded Metal Co., Ltd.

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LIGHT STEEL SECTIONAL CONSTRUCTIONS, LTD.

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GUEST, Keen, Baldwin's Iron & Steel Co., Ltd.
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TOWER LADDERS.
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BRABY, Fredk., & Co., Ltd.
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CROFT Granite Brick & Concrete Co.
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LEWIS Construction.
SHARP Jones & Co., Ltd.

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WATES, Ltd.
WEBSTER, Davidson & Co., Ltd.

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SCAFFOLDING (Great Britain), Ltd.
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SUTCLIFFE, Speakman & Co., Ltd.

WATERPROOFING.
ADAMITE Co., Ltd., "Colemanoid."
"ANTIGASPHALT": Limmer & Trinidad Lake Asphalte Co., Ltd.
BRITISH Bitumen Emulsions, Ltd.
BYRD, A. A., & Co., Ltd.
EXCEL ASPHALTE CO., LTD.
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JONES, Jno. (Steel-Crete), Ltd.
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PERMANITE, Ltd.
R.I.W. Protective Products Co., Ltd.
RIGBY (London), Ltd.
SAL Ferricite Constructions, Ltd,
SEALOCRETE PRODUCTS, LTD.

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BRABY, Fredk., & Co., Ltd.

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BRABY, Fredk., & Co., Ltd.

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WALLING & FLOORING

"ANTIGASPHALT"
A.R.P.

The Air Raid Precautions Department (Home Office) has accepted "Antigasphalt" as a material which can be decontaminated satisfactorily; it can therefore be considered, from that standpoint, for use in Air Raid Precautions construction.

For particulars apply

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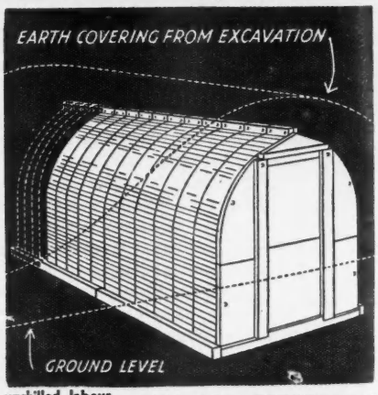
STEEL HOUSE, WESTMINSTER, S.W.1

3 TYPES OF TRIANCO A·R·P SHELTERS

READY TO INSTALL

Trianco Shelters provide quickly available protection for all types of communities and districts. Sectional construction enables accommodation to be arranged to suit requirements, and details can be supplied of suitable grouping of shelters for factories, hospitals, cinemas, tenements, etc. *Write for particulars or state requirements.*



ARCH TYPE SHELTER

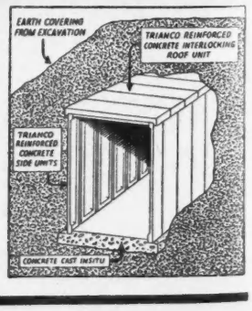
for Industrial, Municipal and Domestic installation. Reinforced concrete construction in sections, easily stored. Speedy erection by unskilled labour. Accommodation as required from 4-6 persons upwards.

LARGER MUNICIPAL & INDUSTRIAL TYPE

Similar to above providing increased accommodation for varying numbers as necessary. Centre partition sanitary cabinet, gas check, air-conditioning equipment, etc., if required.

TRENCH TYPE (to Home Office Approval)

For new or existing trench systems. Reinforced dense concrete sides and interlocking roof units. Special units supplied for 3 and 4 way intersection and emergency exit.


EARTH COVERING FROM EXCAVATION
TRIANCO REINFORCED CONCRETE INTERLOCKING ROOF UNIT
TRIANCO REINFORCED CONCRETE SIDE UNITS
CONCRETE CAST IN SITU

TRIANCO LTD. (Dept. 2),
Imber Court, E. Molesey, Surrey.
Telephone: Emberbrook 3300 (4 lines).

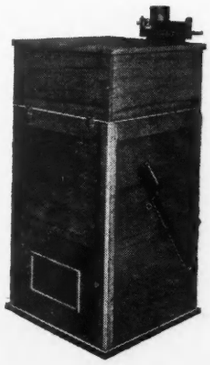
SPACE FOR AN A·R·P SHELTER?

THE PROBLEM OF CONSTRUCTING AN EFFICIENT SHELTER WHERE SPACE IS LIMITED CAN BE SOLVED BY AN EFFICIENT VENTILATION & FILTRATION PLANT . . .

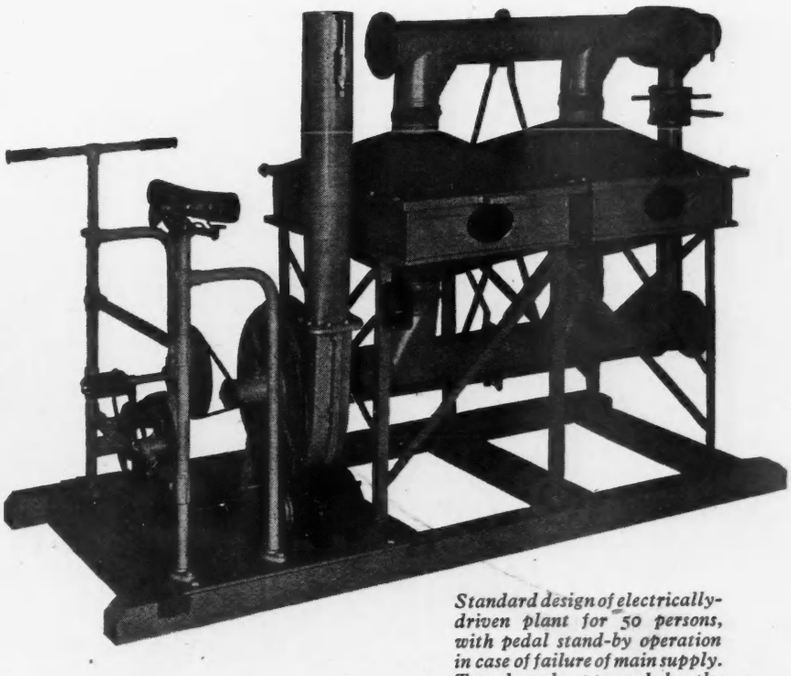
A ventilated shelter need be no more than one-fourth the size of an unventilated shelter, with corresponding reduction of constructional cost per person protected, and much reduced vulnerability to gas and high explosives.

We are supplying suitable ventilation plants for all A.R.P. purposes, over a large range of sizes, from manually operated cabinet types to power-operated plants with pedal or other independent stand-by operation.

We are prepared to submit schemes in co-operation with architects and ventilating engineers.



Cabinet types of plant suitable to small offices and private houses, for from 7 to 140 persons.



Standard design of electrically-driven plant for 50 persons, with pedal stand-by operation in case of failure of main supply. Tested and approved by the Home Office.

SUTCLIFFE, SPEAKMAN & CO. LIMITED

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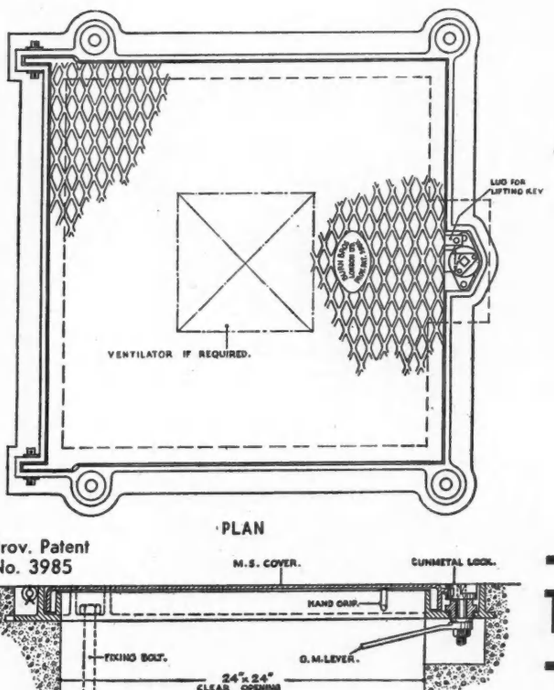
RB A2

A·R·P

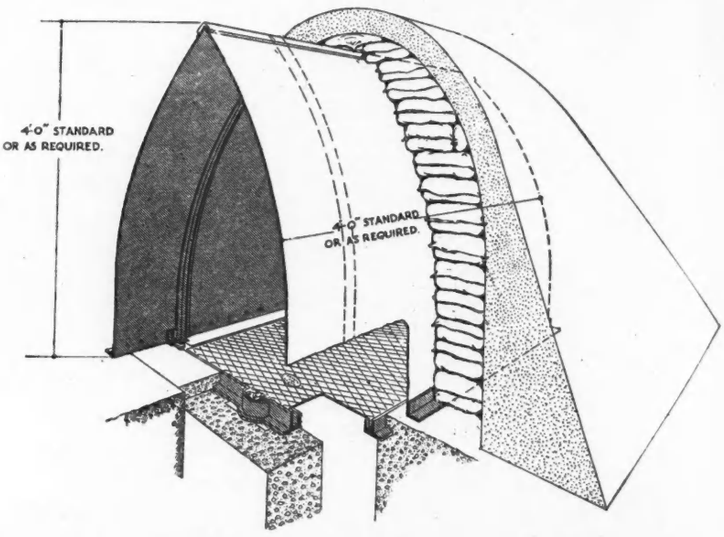
Special AIR, GAS and WATER-TIGHT COVER and FRAME

for Underground Shelters, Factories, Works, Yards and for Wardens' and Control Posts

★



PLAN



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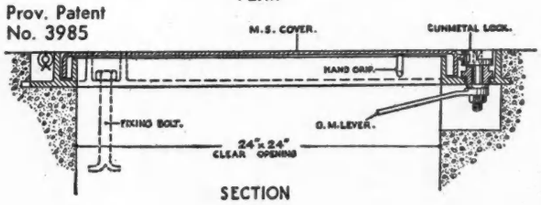

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A complete unit giving reasonable protection against falling debris to entrances and exits of emergency shelters. Easily and quickly assembled. The patent method of GAS-TIGHT HINGEING and LOCKING is foolproof, easily operated from inside or outside, and having extra deep seal, definitely providing a *really* gas-proof shelter. An *unbreakable steel cover* is provided, thereby combining strength with lightness and also eliminating risk of fracture, always present with the ordinary cast-iron cover. Ventilating type is supplied with special device for gas-tight sealing in emergencies.

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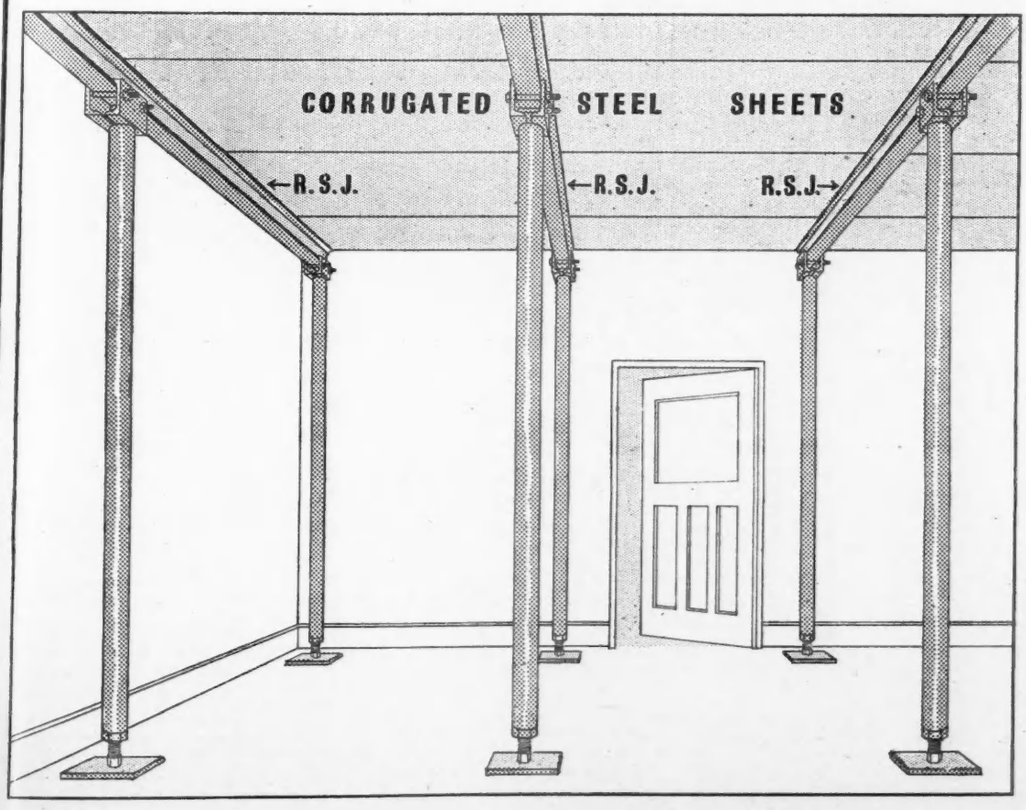

Illustration showing arrangement of steel joists, corrugated iron sheeting and ACROW SPECIAL A.R.P. PROPS—all in accordance with the latest Home Office specification.

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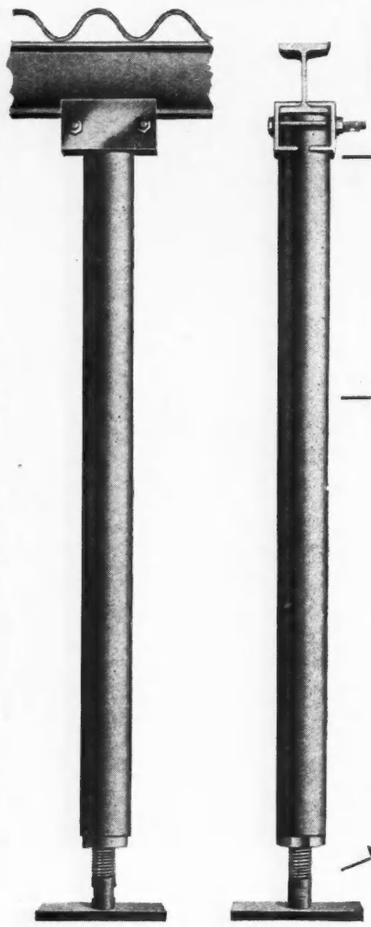
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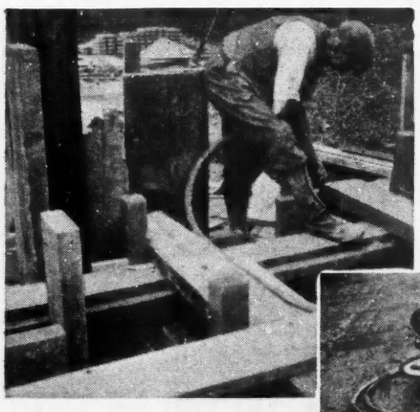

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C.H.J. 229

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DUAL PURPOSE VENTILATION MANHOLE COVER

PROVISIONAL PATENT NO. 3674/39.

The Fraser & Ellis Dual Purpose cover has three main advantages over the loose type of grating suggested by the Home Office

Above—Cover in closed position.

Size 24" x 24" clear opening. Approximate weight 1 cwt. 2 qrs.

When ordering please give depth of shaft from ground level to roof of trench.

Below—Cover open showing secondary cover open to form Ventilating Cover.

● The cover is dual purpose, being available for use as a ventilating cover during peace time and capable of conversion into a sealed gas tight cover in a few moments. It would obviously be very difficult to obtain adequate supplies of sealed covers in time of emergency, and it is advisable, for a slight increase in cost, to be prepared against any contingency. This surely is the whole object of Air Raid Precautions.

● The cover is securely bolted down to the exit shaft and when locked can only be opened from ground level with a key. This obviates any possibility of children lifting the covers and falling into the trenches.

● If an ordinary type of manhole cover is used in time of emergency, it will be very difficult for civilians, using the shelters, to open the cover from the top of the ladder leading to the emergency exit. This difficulty is overcome in the Fraser & Ellis Manhole Cover by the introduction of a lever arm which can be operated from the floor of the trench. The effort required is well within the capabilities of the average person.

All Covers and Frames are cast iron and treated with Dr. Angus Smith's Solution.

Covers and Frames are supplied complete as shown except for Rag Bolts.

Price 57/6 each

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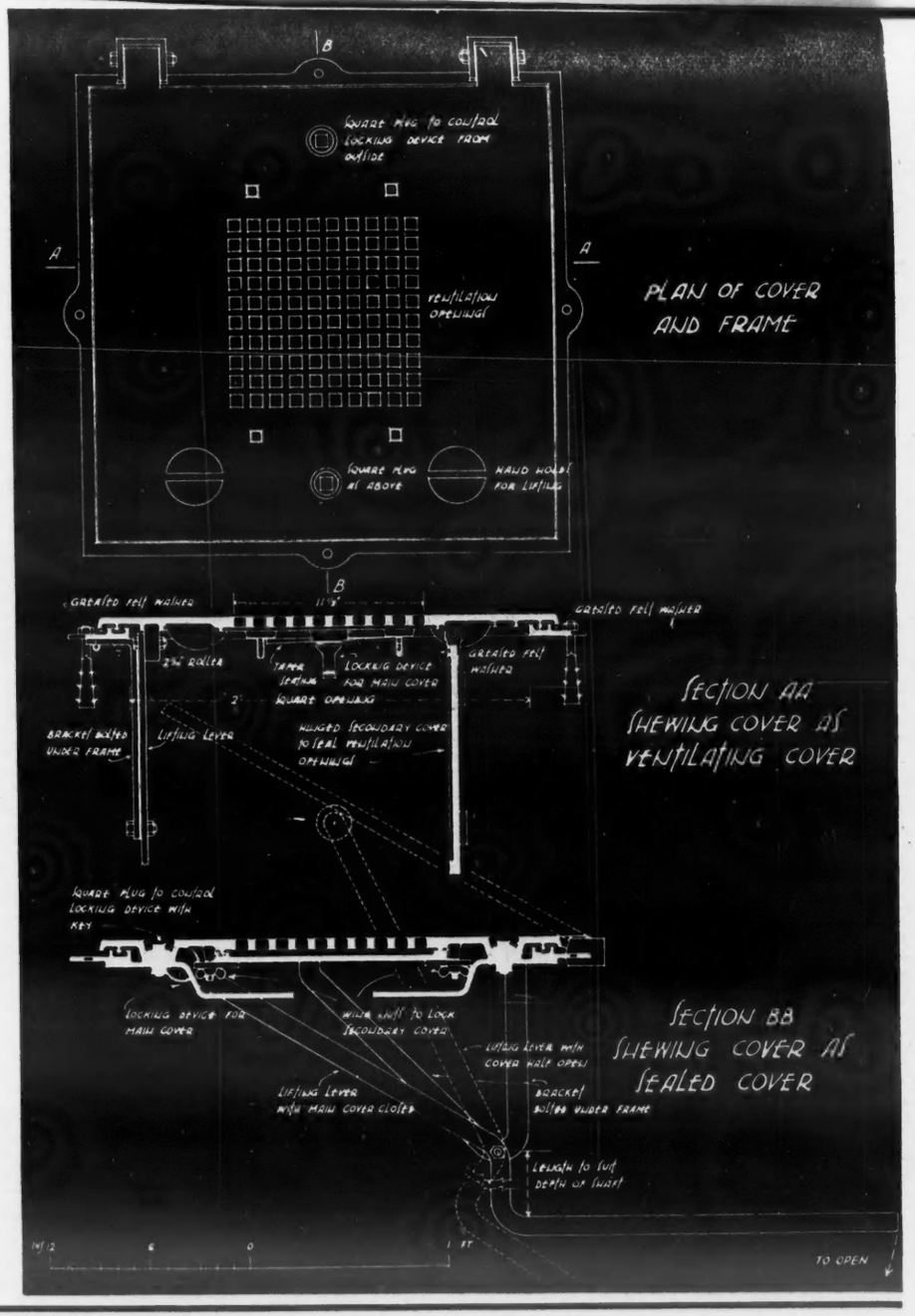

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complete with Doors, Seating, Air Lock, etc.

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for erection by Householder.

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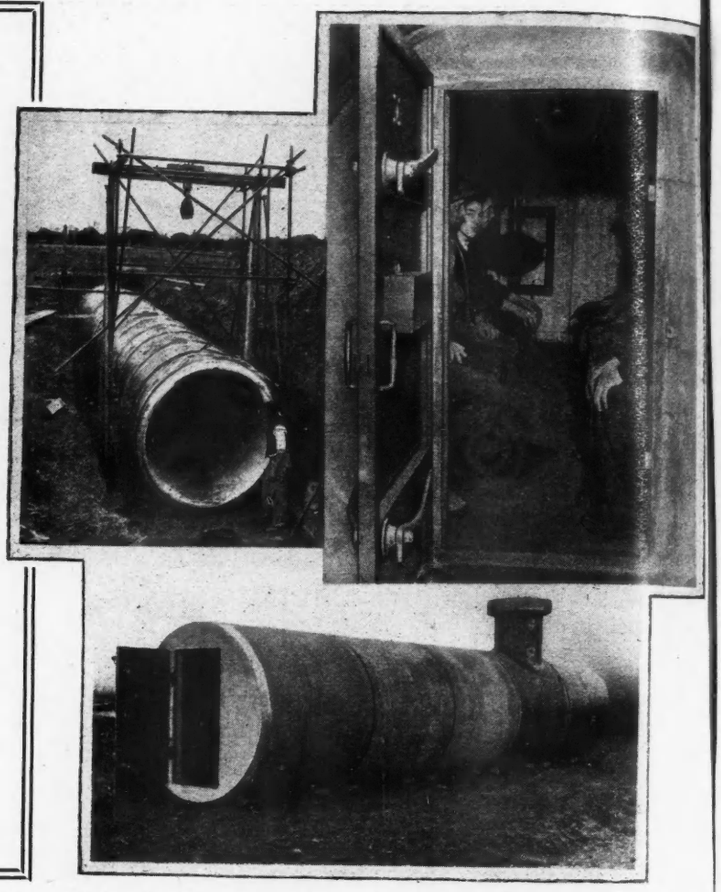

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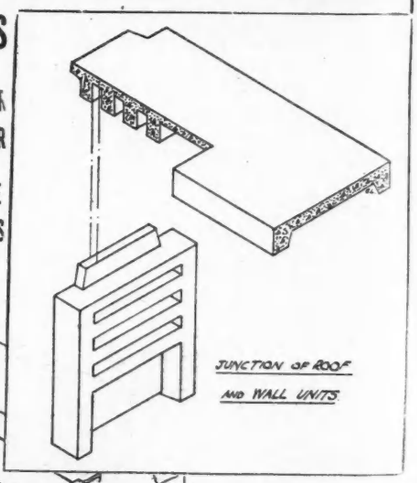

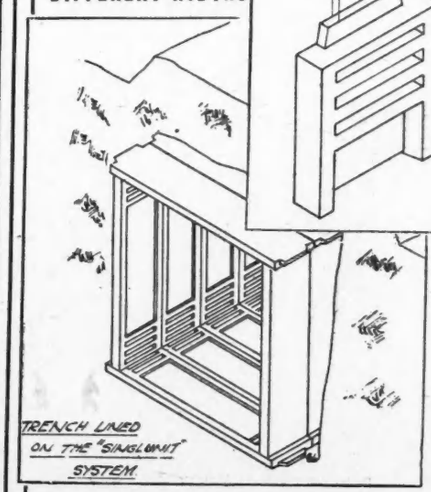

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Is recommended for Waterproofing Concrete and Cement work.

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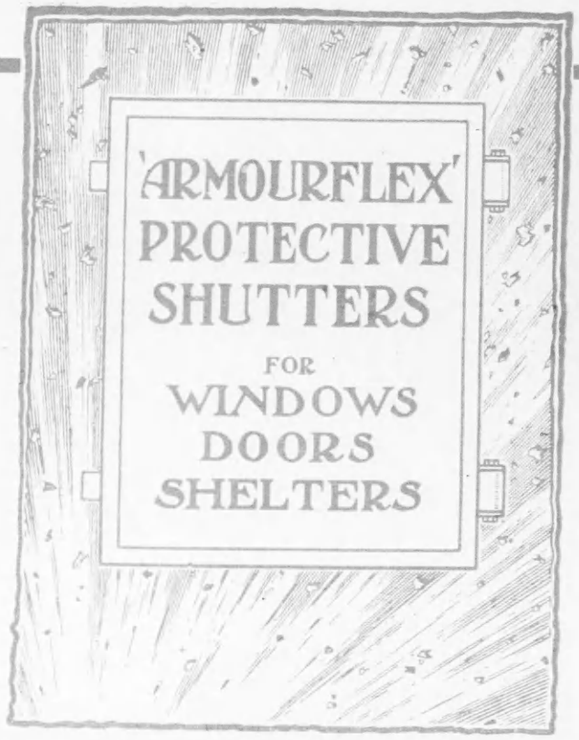
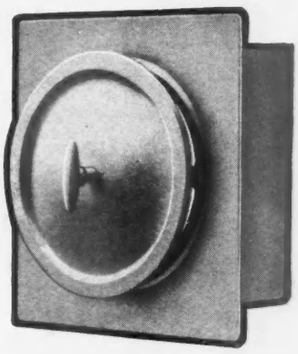
NUVAC "NOGAS" EXTRACTOR
TRADE MARK

The Nuvac Patent "Nogas" Natural Air Extractor is a ventilator which extracts vitiated air from a shelter, building or vehicle irrespective of wind direction.
Fitted with a self-aligning gas-tight valve which positively seals the aperture when closed.
Suitable for Ambulances and vehicles used for livestock and food transport.



MANUFACTURED IN FIVE STRENGTHS



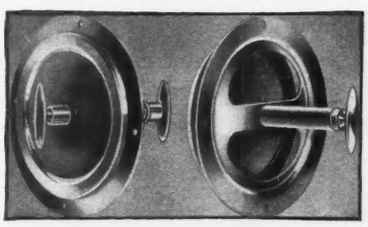
"NOGAS" WALL VENTILATOR
TRADE MARK

The "Nogas" Wall Ventilator, patent pending, is designed to eliminate the necessity for sealing wall ventilators against gas with paper or other medium, an inconvenient process which renders ventilators inoperative for quite lengthy periods when required for general ventilation. Type W.G. 6" x 6" wall box size, is illustrated. Fitted with self-aligning valve.

GREENWOOD-AIRVAC AIR RAID SECURITY PRODUCTS FOR EVERY HOME—FOR EVERY BUSINESS—FOR EVERY SHELTER. "NOGAS" VENTILATORS FOR LARDER, PANTRY, STORE AND KITCHEN. GAS PROTECTION FOR ALL VENTILATED ROOMS AND OFFICES. INSTANTANEOUS AND POSITIVE GAS SEAL BY A HANDLE'S TURN. SPLINTER AND BLAST-RESISTING, FIRE AND HEAT RESISTING SHUTTERS. DIFUSAIRE GAS-FILTRATION UNITS, MECHAVENT FAN UNITS, AND COMPLETE VENTILATION SCHEMES FOR AIR RAID SHELTERS.

"VACAIRE" PATENT EXTRACTOR, MARK 4

The "Vacaire" Patent Natural Air Extractor, Mark 4, designed exclusively for Air Raid Shelters, operates at very low air speeds of from one mile an hour upwards to hurricane force with wind blowing from any quarter. Maintains a fresh, healthy interior. No moving parts. Weatherproof.



"NOGAS" VENTILATOR
TRADE MARK

Type D.C., patent pending, is designed for a number of purposes. Used in conjunction with the "Vacaire" Extractor and Intake as described below, it ensures absolute security against gas entering a shelter via the ventilation system.
As a door ventilator it is especially suitable for keeping the atmosphere in cupboards, larders, stores, etc., sweet and fresh.

The Greenwood-Airvac Intake is designed for use with the Vacaire Extractor. It is fitted to the inlet pipe, and so constructed that fresh air is automatically deflected into the inlet pipe, thus replacing the vitiated air extracted by its component. Weatherproof.

GREENWOOD-AIRVAC REGISTERED AIR INTAKE

A unique, secure, and complete natural ventilation system for Air Raid Shelters available at a moderate cost, consisting of the "Vacaire" Extractor fitted to piping inserted near the entrance or air lock, the Greenwood-Airvac Intake being attached to piping near the opposite end The extract and intake pipes are fitted inside the shelter with "Nogas" type D.G. Ventilators which, at a slight twist of the handle provide instant seal against gas.

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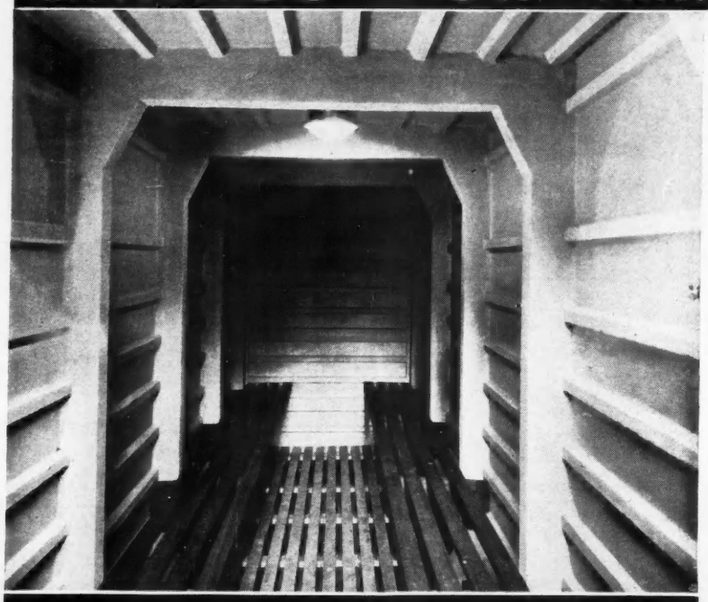
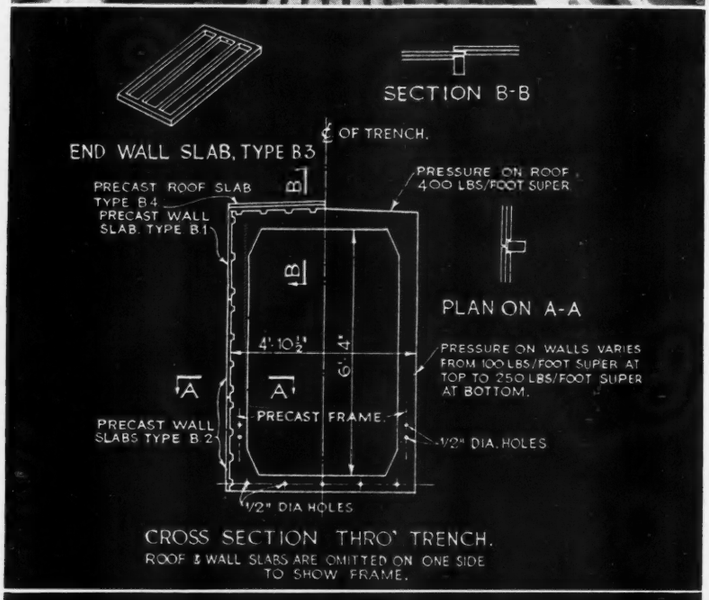
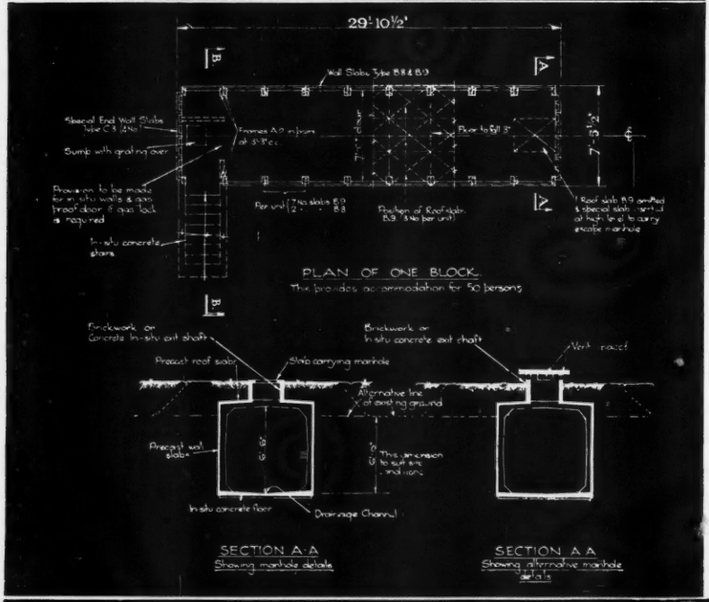



SECTION B-B
℄ OF TRENCH.
END WALL SLAB, TYPE B3
PRECAST ROOF SLAB TYPE B4
PRECAST WALL SLAB, TYPE B1
PRESSURE ON ROOF 400 LBS/FOOT SUPER
PLAN ON A-A
4'-10½"
PRESSURE ON WALLS VARIES FROM 100 LBS/FOOT SUPER AT TOP TO 250 LBS/FOOT SUPER AT BOTTOM.
PRECAST FRAME.
PRECAST WALL SLABS TYPE B2
½" DIA. HOLES
½" DIA HOLES

CROSS SECTION THRO' TRENCH.
ROOF & WALL SLABS ARE OMITTED ON ONE SIDE TO SHOW FRAME.



TRENCHES AND SHELTERS.

Pre-cast Concrete Shelter Lining in accordance with approved Home Office Design No. 704326/9 possesses unique features, being designed in rigid framed units, free from rebates and highly resistant to collapse.

DESCRIPTION.

The rigid frames, clearly seen in the photograph, are strengthened at the haunches, and form a rigid one-piece unit. There are three types of lining available, all approved by the Home Office, including a 7-ft. wide system of the Air Ministry type.

ERECTION.

Can be easily erected by semi-skilled labour.

ACCOMMODATION.

The shelter shown in the lower diagram provides accommodation for 50 persons. Alternative accommodation can be constructed by standard Home Office 5-ft. wide trenches, and Messrs. J. A. King & Co. Ltd. will be pleased to submit suitable schemes and estimates for any particular conditions and any number of persons to be accommodated.

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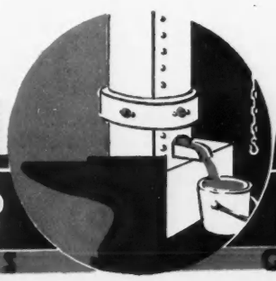

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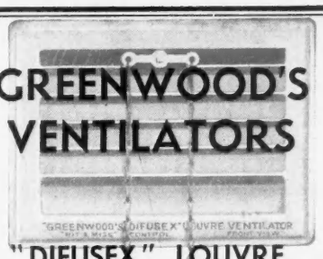

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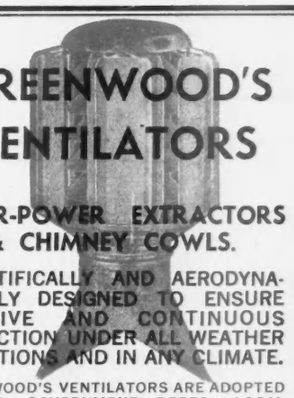

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SUPER-POWER EXTRACTORS & CHIMNEY COWLS.

SCIENTIFICALLY AND AERODYNAMICALLY DESIGNED TO ENSURE POSITIVE AND CONTINUOUS EXTRACTION UNDER ALL WEATHER CONDITIONS AND IN ANY CLIMATE.

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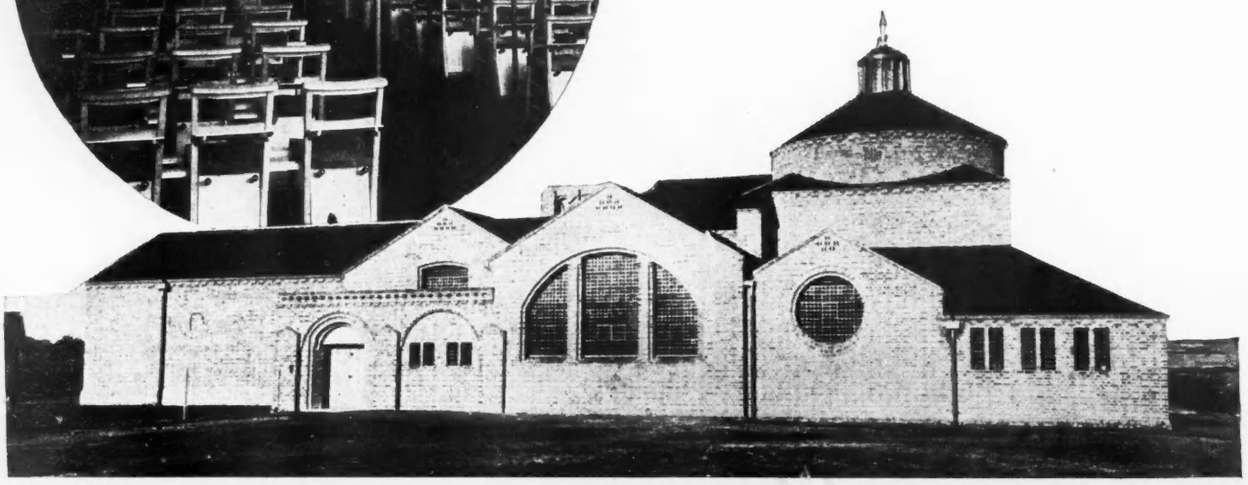

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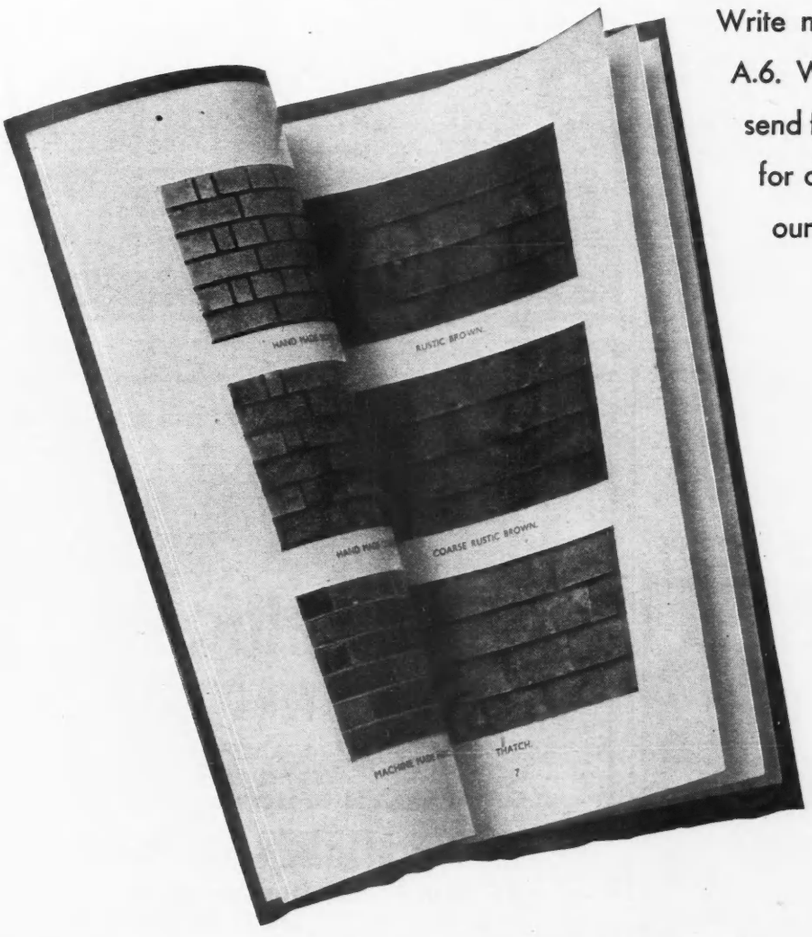

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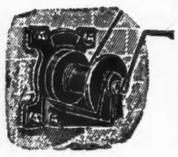

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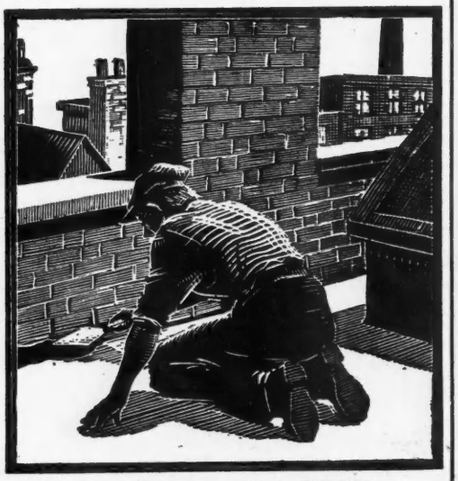

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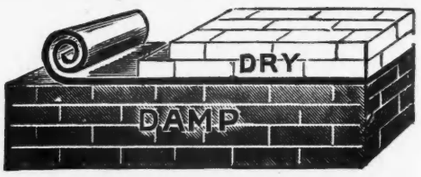

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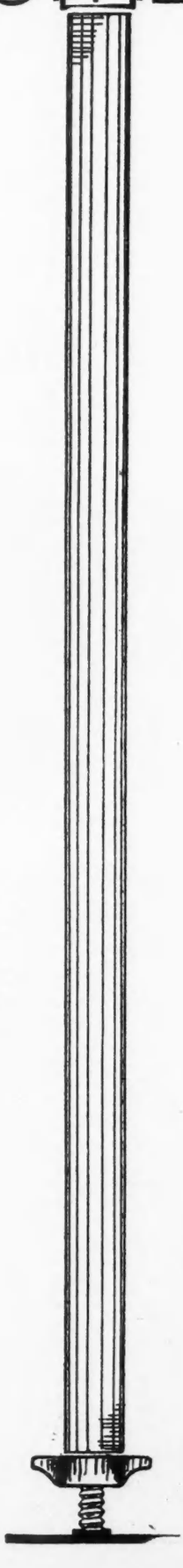

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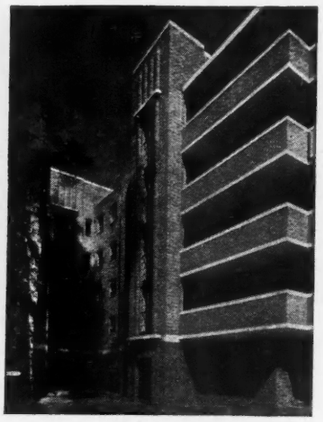

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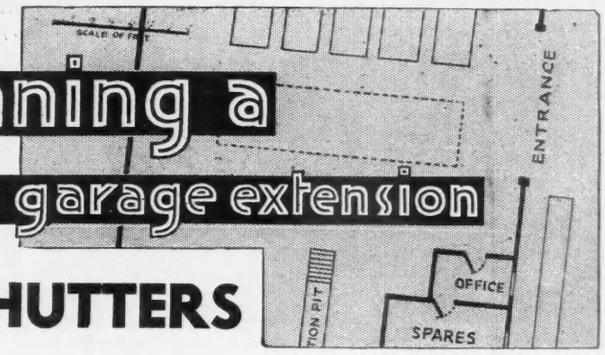

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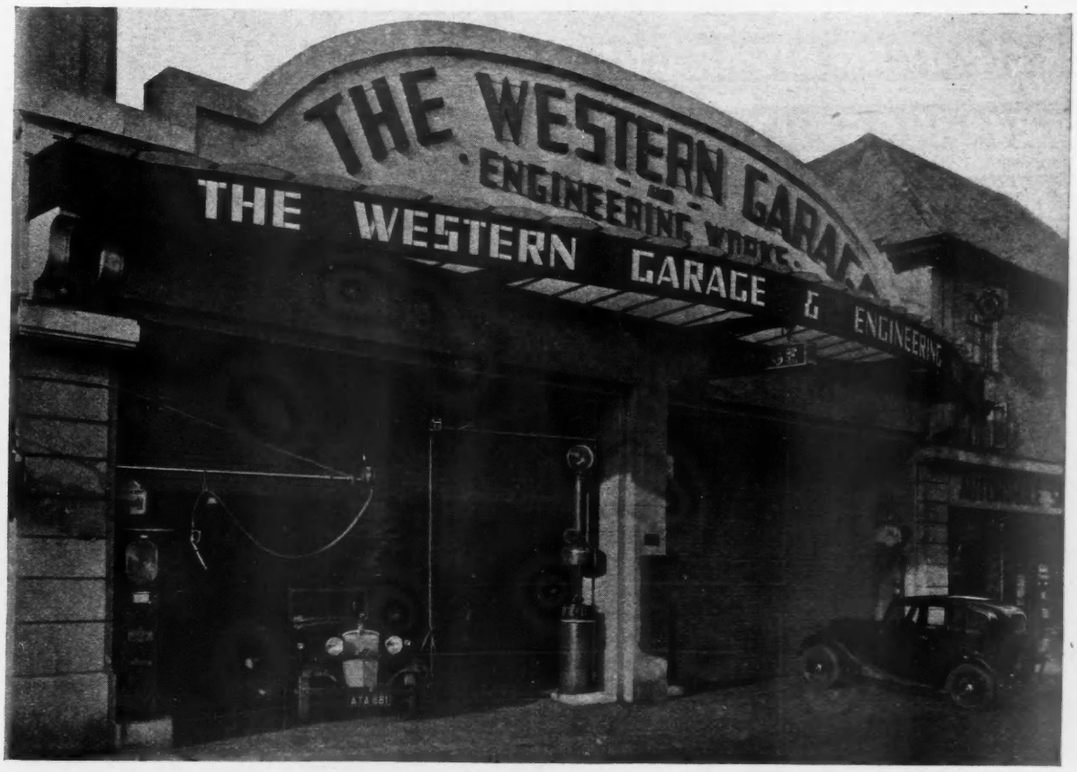

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Why they revised the original plan and decided to use GAS

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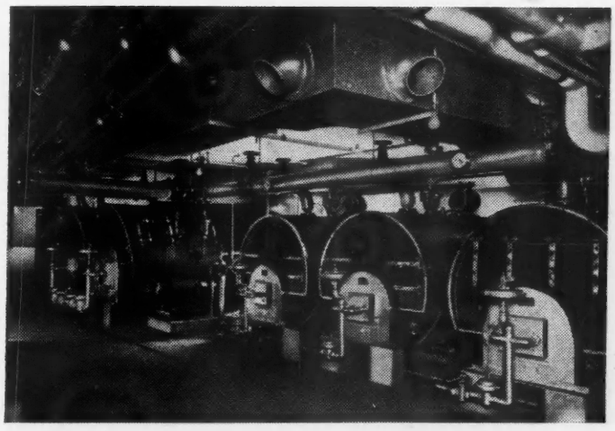
THE GAS-FIRED PLANT

The plant comprises three water heaters, each of 1,050,000 B.Th.U. per hour, and two steam boilers, each of 2,300,000 B.Th.U. per hour. These serve both the new and the old buildings, the total capacity of which is approximately 1,700,000 cubic feet. The equipment used has a guaranteed efficiency of 80 per cent.



Installed by Messrs. Richard Crittall & Co., Ltd.

The gas-fired boilers at the "Daily Express" office—one of the largest gas-fired installations in the country.

The water heaters serve the invisible panel warming system which has been adopted throughout the building. A thermostatically controlled modulator ensures that the water does not exceed the desired temperature, while a high temperature safety device prevents overheating should any failure of the plant occur.

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The steam boilers supply the steam for heating the ventilating and air-conditioning batteries. The air-conditioning systems are very extensive and serve the machine-room, compositors' department, foundry and entrance hall. There are three separate air-conditioning units with exhaust fans for removing the vitiated air.

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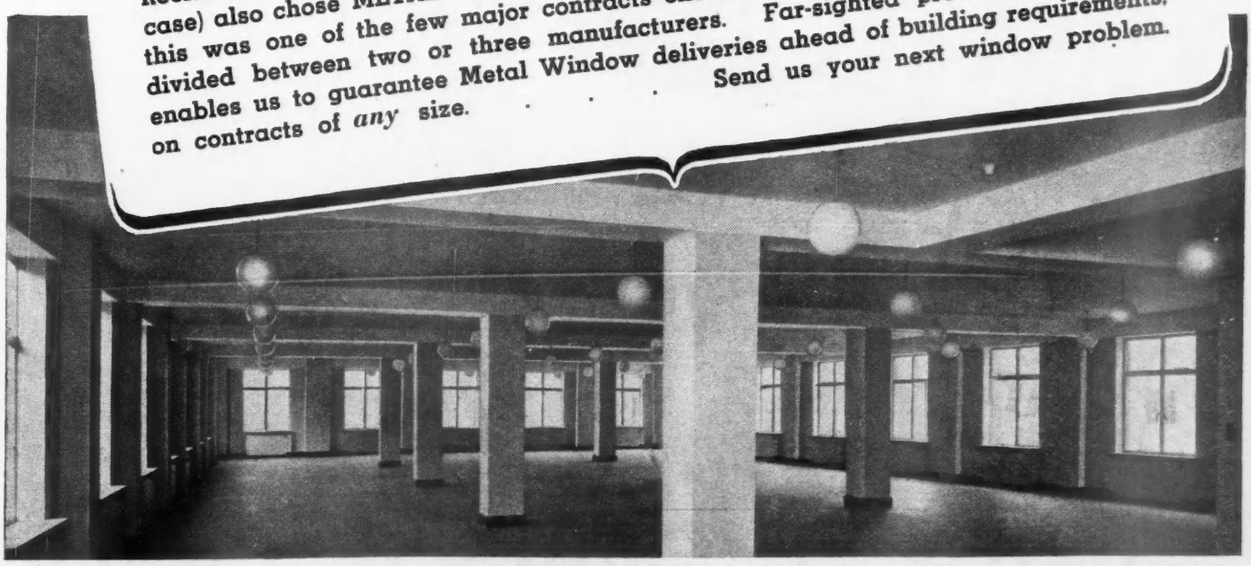

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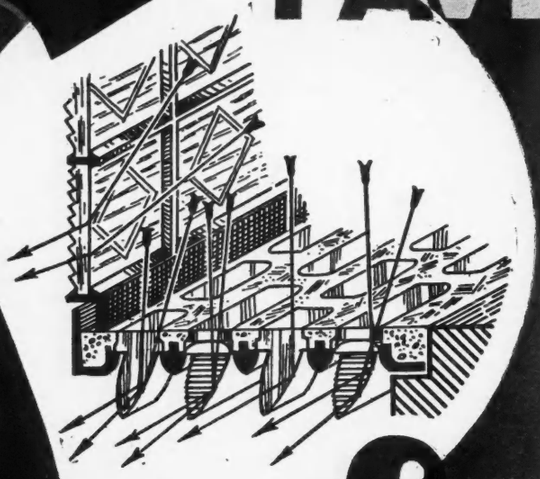

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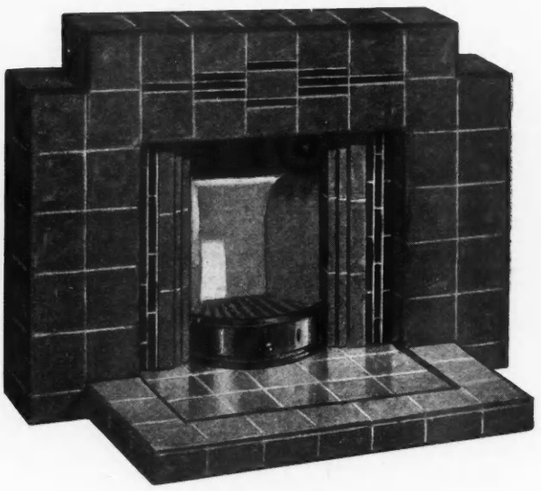

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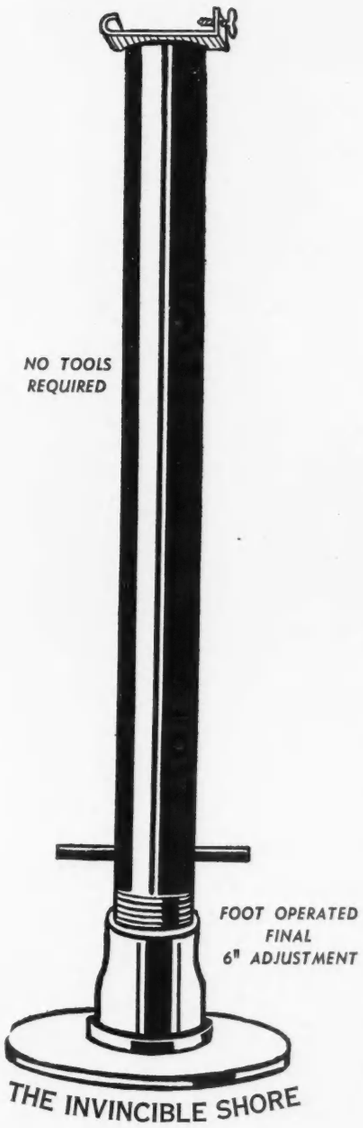

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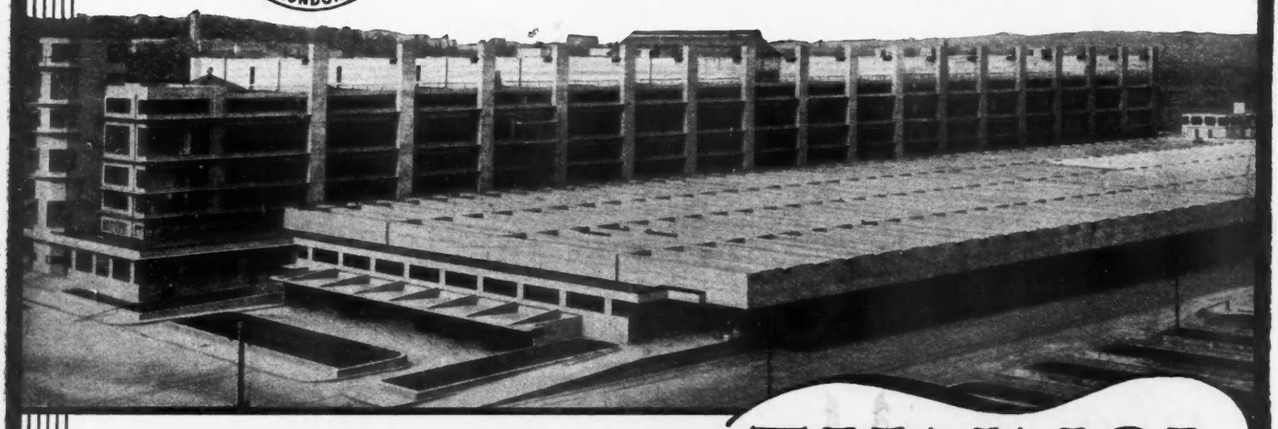

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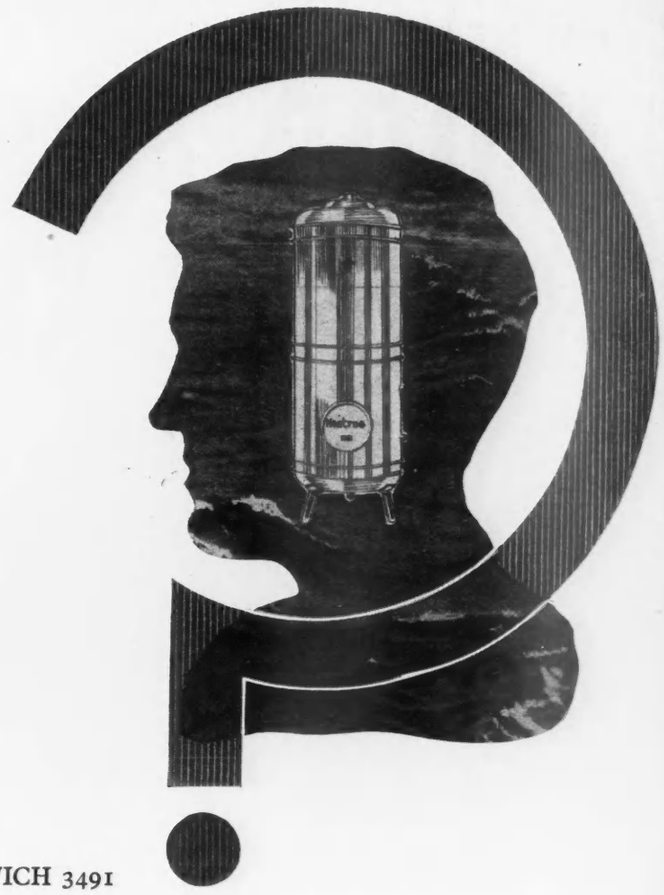

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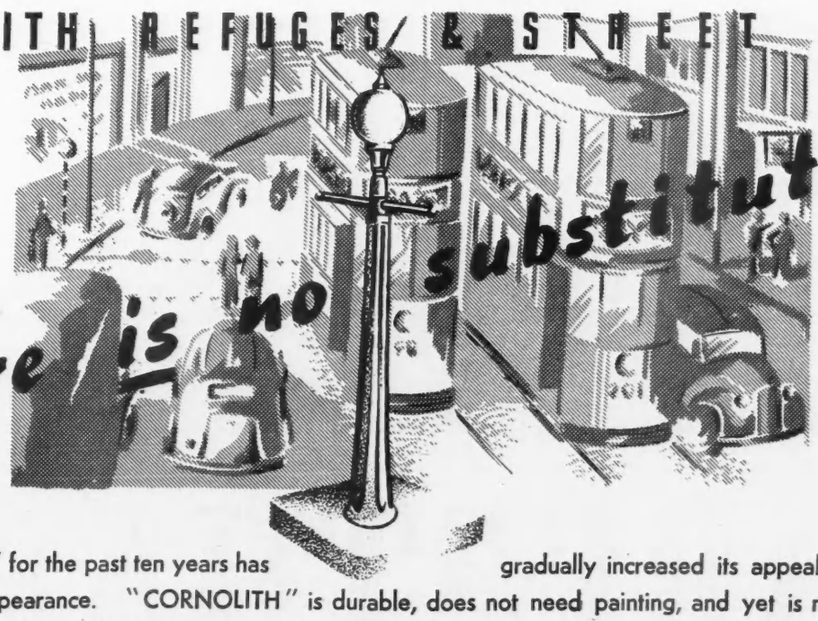

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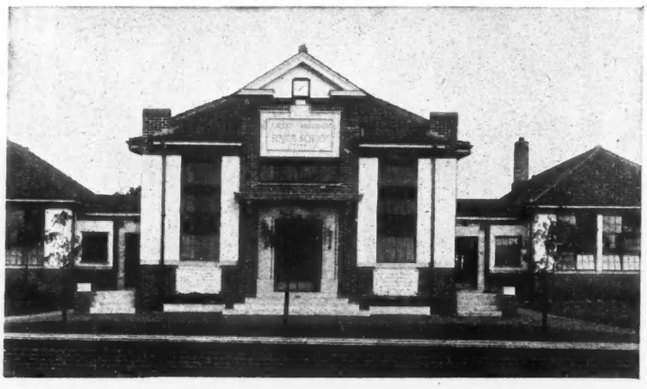

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WHAT HO! BLISSETT

"The flowers that bloom in the spring, tra-la . . . . . I think another sausage is indicated, Blissett."

"Another sausage, sir?"

"Absolutely, Blissett. Do I detect a faint note of surprise in the air?"

"I beg your pardon, sir, but this is so sudden. Of late I had begun to think that the iron had entered deep into your soul, sir."

"Not into my soul, Blissett. Rather into the Works—Scrap Iron in fact. A rapid rise was noted in overheads and the Works Manager's blood pressure."

"I trust everything is now satisfactory, sir."

"Infinitely, Blissett, thanks to George Cohen's."

"George Cohen's, sir?"

"But definitely, Blissett. Never mind if some heaven-sent organizer piles scrap iron up to the fifth story, stows it in the pattern shop, heaps it in the drawing office. Just add a dash of George Cohen's Super-service and—Bingo! Works clear, head unbowed!"

"Remarkable, sir!"

"Remarkable is the word, Blissett. A Scrap-Iron tonic, in fact."

Advertisement of GEORGE COHEN, SONS & CO., LTD. (Established 1834), Scrap Iron and Metal Merchants, of 600, Commercial Road, London, E.14, and Birmingham, Manchester, Sheffield, Newcastle, Belfast, etc.

With apologies to Mr. Rose's admirable Lime Juice, and rebutting the suggestion that "by any other name" . . . . etc.

ALL KINDS OF

SCAFFOLDING

CONTRACT, SALE OR HIRE

THE SPECIALISTS IN THE ERECTION OF

TRAVELLING CRADLES
BUILDERS' PLANT

OF EVERY DESCRIPTION FOR

SALE OR HIRE

SEND US A LIST OF YOUR REQUIREMENTS AND WE WILL QUOTE YOU.

THE OLDEST ESTABLISHED FIRM IN THE SCAFFOLDING TRADE

STEPHENS & CARTER, LTD.

incorporating THE BRITISH STEEL SCAFFOLDING CO.

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Telephone: Reliance 2169.

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BRANCH AND WORKS:
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Telephone: Willesden 4825.

BIRMINGHAM BRANCH:
114, IRVING STREET,
BIRMINGHAM, 15.
Telephone: Midland 6011.

NORWICH BRANCH:
RIVERSIDE WORKS,
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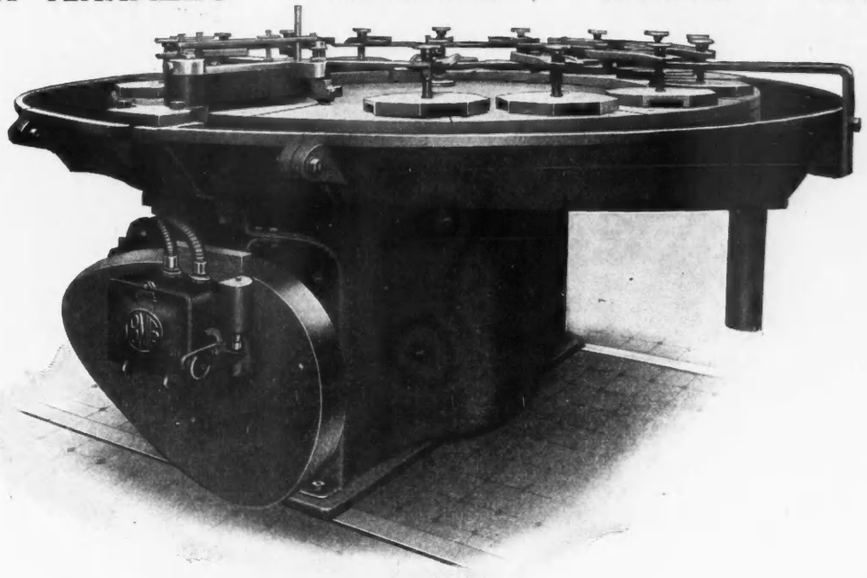
Telephone: Norwich 851.

ELLIS TILE FINISHING MACHINE

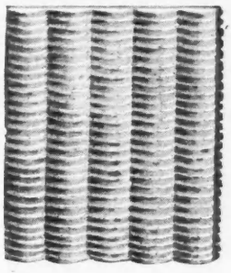
FOR TERRAZZO — CULLAMIX — MARBLE — ETC.



A MODERN MACHINE with outstanding advantages
CONTINUOUS OPERATION
CHEAP RUNNING COSTS
CONSISTENT HIGH OUTPUT
PERFECTLY FLAT — TRUE TILE SURFACE
EDGES AND CORNERS UNDAMAGED

SEND FOR PARTICULARS **ELLIS BROS. (Leicester) LTD.**
CAUSEWAY LANE, LEICESTER

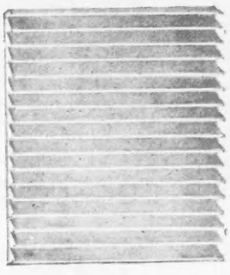
MAXimum Light GLASS gives 5-20 times MORE LIGHT!



MAXIMUM LIGHT GLASS

An effective method of increasing daylight is by the use of MAXimum Light Window Glass. This remarkable glass is the only glass combining lenses and prisms, and its superiority can be judged by the fact that it increases natural daylight from 5 to 20 times, according to circumstances. MAXimum Light Glass is particularly effective in stall-board lights to basements and in sashes and skylights.

Alternatively, Prismatic Rolled Glass can be employed. This glass consists of an effectual application of the well-known properties of the Prism—absorbing all the light that strikes the window opening, and diffusing it in the most efficient manner possible into the darkest portions of the apartment. Ordinary glass can be replaced by Prismatic Glass. It increases the Daylight in dark offices, rooms, workshops, basements, corridors.



PRISMATIC GLASS

IF YOU HAVE A PROBLEM IN "DAYLIGHT INCREASE" CONSULT THE SPECIALISTS

EATON, PARR & GIBSON, LIMITED

Plate and Sheet Glass Merchants and Glaziers. 41, 43, 45, 47, 49, 51 & 53, Kingsland Rd., London, E.2.
'Phones: Clerkenwell 1040 (10 lines). 'Grams: Measurement, Beth, London.

40.81

The Key to a dry house-

No. 2 METALLIC LIQUID

The destructive effect of persistent dampness can be entirely overcome by the use of this solution. A house that is damp can be made bone dry by simply brushing No. 2 Metallic Liquid on the exterior walls. No discolouration of the walls will result from its use, but capillary attraction will be destroyed and the wall made impervious to the most penetrating rains. The application of Lillington's No. 2 Metallic Liquid is not dependent on the weather. It can be used

AT ANY TIME OF THE YEAR

It is unnecessary for a wall to dry-out before the solution is applied.

The cost is low, 6/- to 8/- a gallon according to quantity. Sold under guarantee.

There is a LILLINGTON solution for every waterproofing problem.

WRITE FOR BOOKLET B containing interesting damp proofing data to

GEORGE LILLINGTON AND CO. LTD.

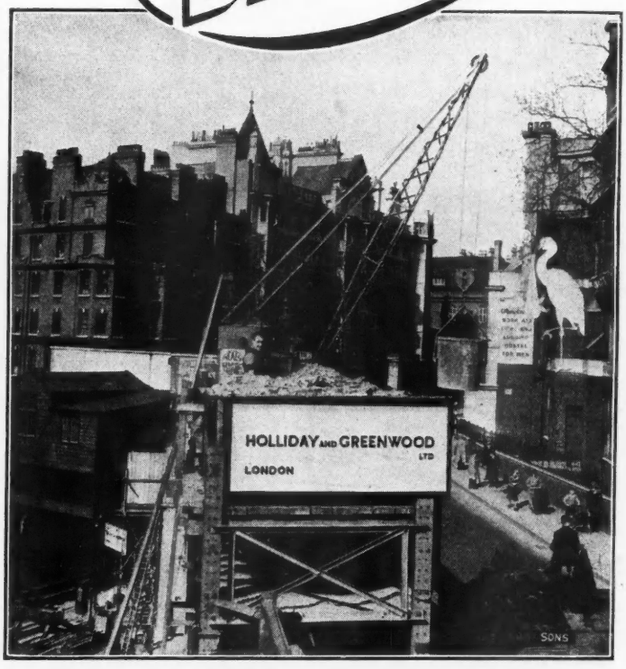
Waterproofing Specialists

30, DENMAN STREET, LONDON BRIDGE, S.E.1

Phone: Hop 1768.

Scottish Office: 78, Vincent Street, Glasgow, C.2.

THE SMALL CRANES YOU SEE ON THE BIG JOBS



A 15-cwt. "Rapid" crane at work on the extensions at Edgware Road Station. Note the 18 ft. lattice jib.

NEAL'S "RAPID"

PETROL CRANES

6, 8, 12 and 15 cwt. capacities.

- Full circle slewing. Power operated on 12 and 15 cwt. models.
- All models fitted with Neal's Safe Load-sustaining device.
- Powerful slow speed "Lister" Petrol engine, for economy and efficiency.
- Mounted on steerable road wheels (either iron or rubber tyres) or on combined road and rail wheels.
- Special jibs and extension masts to customers' requirements.

Designed and manufactured by:

R. H. NEAL & CO. LTD., PLANT HOUSE, EALING, W.5

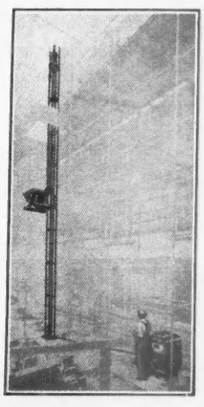
SNAP!

and **IMMEDIATELY**

the Parker Safety device

ACTS!

PARKER "HOISTEX" EQUIPMENT



The Parker Safety Device fitted to every "HOISTEX" Tower Hoist ensures maximum security with continuous service.

The Safety Device is designed to sustain the platform in the event of rope breaking. No case has yet been reported to us of failure of this device to act.

"HOISTEX" Equipment is fast—reliable—adaptable. The Tower can be extended to the next stage without ceasing operations—and overcomes all previous erection difficulties on awkward locations.

"HOISTEX" is the Hoisting Equipment you would have designed yourself—let us give you full particulars and you will agree that "HOISTEX" has it all!

"HOISTEX" Equipment includes: The Parker Hoist, Floor Hoppers, Concrete Hoppers, Single or Double Barrow Platforms, Tipping Skips, etc., and is operated, of course, by the famous PARKER HOIST WITH ENGINE.

"HOISTEX" Equipment can be purchased for cash or extended terms—or Hired with or without Option to Purchase.

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LONDON OFFICE: 3P, Talbot House, Arundel Street, Strand, W.C.2. **Phone: 4239 and 2739 Temple Bar, London.**

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The photograph shows a section of the extensive works of Kent & Sussex Contractors Ltd.

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'Kent & Sussex' are actual makers of the 5ft. and 7ft. pre-cast concrete units.

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CARLTON RD., ERITH, KENT.
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Specialists in Air Raid Shelters

TRENCH COVERS & BEARERS

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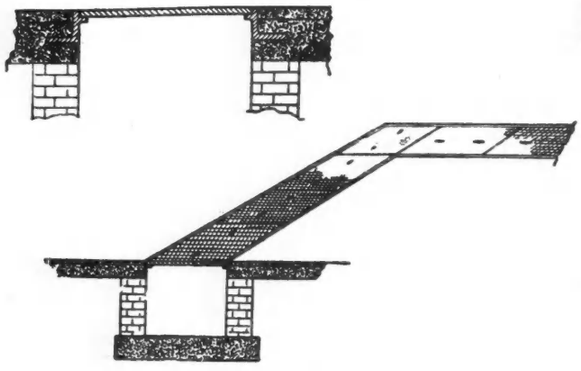
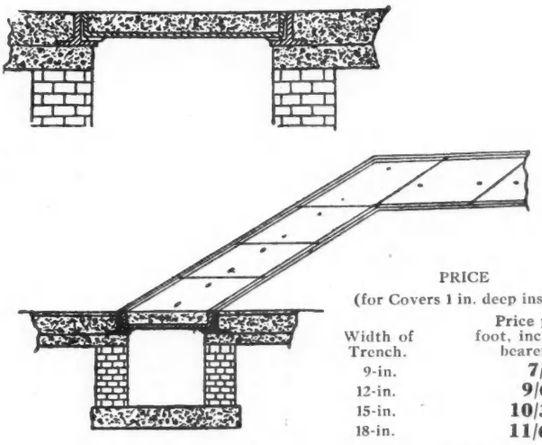
STEEL
CHEQUER PLATE.



PRICE
ON
APPLICATION.

TYPE C.
CAST-IRON DISHED TRAY



COVERS CAN BE SUPPLIED
ANY DEPTH TO SUIT
FLOORING MATERIAL.

PRICE
(for Covers 1 in. deep inside).

Width of Trench.	Price per foot, including bearers.
9-in.	7/-
12-in.	9/6
15-in.	10/3
18-in.	11/6

DEEPER COVERS
AT EXTRA COST

ASHWELL & NESBIT, LTD.
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ALSO AT LONDON, GLASGOW, MANCHESTER & BIRMINGHAM

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AVOID THE DELAY WHICH OTHER HUTMENT CONTRACTORS ARE EXPERIENCING AND OBTAIN QUICK DELIVERIES OF

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FROM

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MELBOURNE HOUSE, ALDWYCH, LONDON, W.C.2.

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WHO HAVE LARGE STOCKS AT THEIR EXTENSIVE AND MODERN SAW MILLS AT

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NEW DOCKS, SOUTHAMPTON
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AND CAN GUARANTEE **PROMPT DELIVERY** OF
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OR **ANY QUANTITY**
TO **ANYWHERE**

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THE ORIGINATORS OF THE ACCEPTED METHOD OF BASEMENT REINFORCEMENT

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CUT COSTS AS WELL AS TIMBER

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An ingenious portable saw-bench which rips, cross-cuts, bevels and bores—*right on the site.* Costs decrease daily as you use it, because you can buy larger timber at cheaper rates and cut as required. It weighs only 11 cwt. . . . easily moved about . . . own self-contained petrol engine . . . requires no skilled attention . . . and you can rely on it!

Write for further details to

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THE LINER CONCRETE MACHINERY COMPANY,

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Simply PRESS to open!

WHEN a hand grasps the handle, the thumb falls naturally on the plunger. Light pressure – and the catch of the lock is released. Simple, convenient – and pleasing to the eye.

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PLUNGER HANDLE LOCKSET

For flush and all other interior doors. Easily fixed. Available with round or hexagonal barrel and in three attractive finishes. Made throughout in our own factory and guaranteed reliable. Please ask for descriptive folder.

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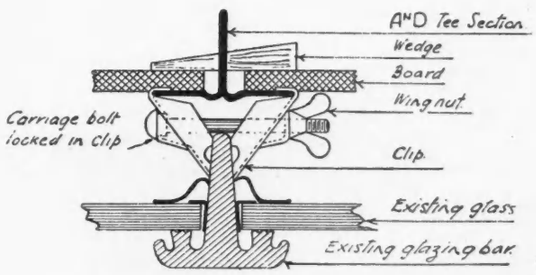
Nettlefold House, Euston Rd., London, N.W.1
Phone: Euston 5040

AND WEDGE METHOD

(PATENT APPLICATION No. 34383/38)

OBSCURATION OF LIGHT



A.R.P. THE NEW CIVIL DEFENCE BILL. One of the paragraphs reads as follows:—

"All persons in control of factories, mines, and public utility undertakings will be required to make preparations to obscure lighting and glare in time of war, and in many instances the premises will have to be camouflaged."

The solving of this problem has given Managers of Industrial Companies great concern and many schemes have had their consideration. We have adapted the now well-known AnD Wedge Method of fixing boards, a scheme which, for efficiency and simplicity, has much to recommend it, and the sketch shown gives the main features of its application.

It can be used on any type of glazing bar and is fixed by unskilled labour. The slotted T-Sections are permanently placed in position by means of special clips and left until it is necessary to obscure lights. When warning is issued to proceed with the obscuration, selected opaque boards can be fixed in a very short time by means of wedges which, being fixed without nails or screws, can be removed quickly and easily without damage.

An adaptation of this method can also be used on vertical windows.

We invite your enquiries for a blue print of this method, which can be applied at reasonable cost.

C. F. ANDERSON & SON LTD

Distributors of all wallboards

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will solve your flooring problem

Mastipave is an asphaltic fiberized floor covering which will withstand extraordinary conditions of wear and provides an inexpensive low maintenance attractive flooring for all industrial, commercial and institutional purposes.

Mastipave is resilient, self-healing, non-slip and resistant to severe wear, acid, water, rot and vermin. It is made from a specially selected Felt impregnated with asphaltum and other ingredients to make a homogeneous and wear-resistant material. It reduces fire risks and is not defaced by lighted cigarettes.

Mastipave is the practical covering for large area floors, and possesses the combined qualities of durability, economy and good appearance.

MASTIPAVE is available in several appealing colours in rolls or tile form. It is applied by cold cementing with MASTIPAVE cement to the floor base.

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When you Specify and Use

SPHINX

DAMPCOURSES, ROOFINGS & BUILDING PRODUCTS

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DAMP COURSES
Lead & Bitumen
"X.L." (*Hessian base*)
"S.P." (*Fibre base*)

FELTS
Untearable Felt
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Road Jointing

"SPHINX" Plastic

"SUBLINO" Cork Felt
(*for Cement Floors*)

SPHINX FLAT ROOFING
for concrete or wood flats; approved by leading Architects.

SPHINX HOLLOW PARTITION BLOCKS
for Noiseproof and Fireproof Partitions, &c.

you assure your buildings of the most perfect, lasting protection against all weather conditions. Yet their cost, based on years of service, is remarkably low. Remember, there's a SPHINX product for every waterproofing need—for every class of building.

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Durex Works, Preston - - " 4460
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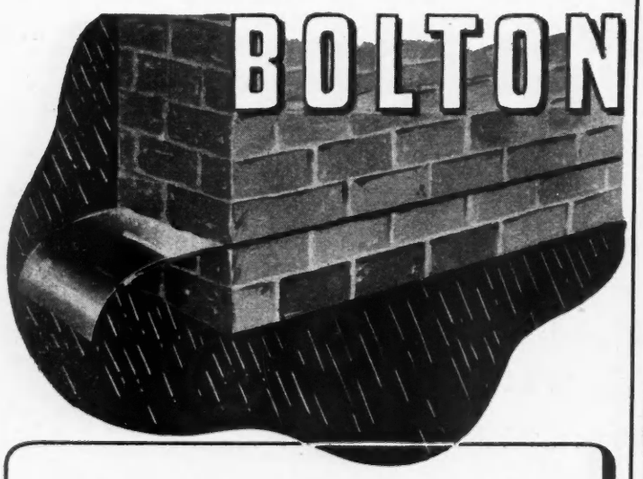

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Copper strip is the ideal material for a damp-proof course. Being of solid metal, highly resistant to corrosion, it is permanently waterproof. Supplied in rolls, it is easily and quickly laid. It will not squeeze out, even under the heaviest structures, and will not crack under settling stresses.

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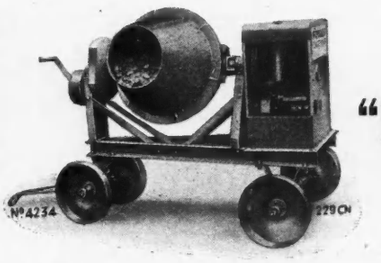

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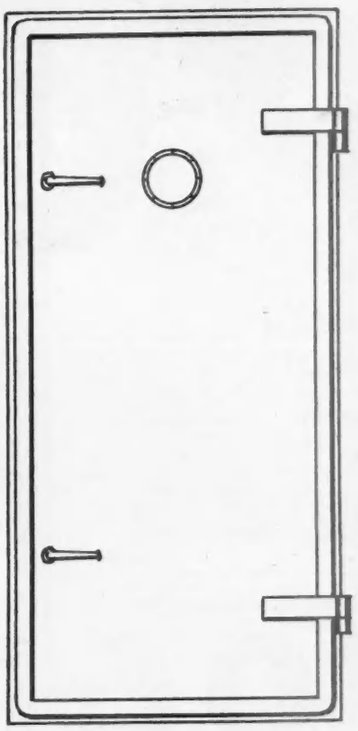
IT IS BETTER TO BE SAFE THAN SORRY



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PURPOSE OR STANDARD MADE

SOLID MILD STEEL PLATES

from 14g. to 1½" thickness.

Sorbo Sheathed Rubber Gaskets. Reinforced Wired Plate Glass Peepholes.

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CAN BE MADE IN SINGLE OR DOUBLE UNITS OR TO SLIDE

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FAST WORK!

With the 4 in. HOMELITE PUMP

32,000 GALLS. PER HOUR CAPACITY.

All machines can be fitted with BRANCH PIPES FOR FIRE FIGHTING.

SUCTION LIFT 28 ft. 6 in.

The 3 in. size pumps 12,000 galls., 2 in. 6,000 galls., per HOUR. *Write for details if interested.*

HUNDREDS of HOMELITE PUMPS NOW IN USE ON **A.R.P. WORK**

Above is pictured the HOMELITE 4 in. heavy capacity 32,000 galls. per hour Pump. Heads up to 50 ft. One unit pump and 12-h.p. engine for extreme simplicity; no extra shafts, no couplings, no bearings; no extra priming pump. Once primed—ALWAYS primed. For seepage: one gall. per hour. **See actual demonstration—any time—any place at our expense entirely.** Investigate fully our claims of amazing performance and lowest running costs. *Write for leaflets.*

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JOHNSON CONTRACTORS' PLANT

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200, Irkdale Street, Manchester, 8.
Est. 1790

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We invite you
to make application for your copy of our 1939-40 catalogue — now ready for distribution

and also, we invite you ——
to *see* what you buy *before* you buy

Each of our representatives carries a 2-light specimen frame—one you can examine closely, at your leisure. They, and we, will be happy if you will make use of this opportunity to study the merits of our

"RAINTITE" WINDOWS
Patent Nos. 477,570 & 464,933

Rainproof: draughtproof:
complete freedom from "easing" sashes

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2-WAY REINFORCED FIREPROOF FLOORS
ERECTED ON TELESCOPIC CENTERS

ALL-CONCRETE CONSTRUCTION

● Constructed with patent hollow concrete blocks and two-way reinforcement, on unique steel telescopic centers, the Smith's Fireproof Floor is the most efficient and up-to-date reinforced concrete floor available.

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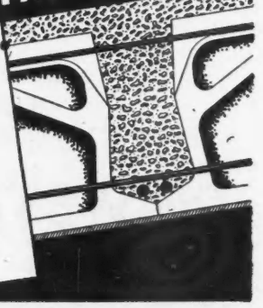


● Exceptional popularity—proved in hundreds of buildings—has been attained by sheer merit in design, performance and speed of construction.

SMITH'S FIREPROOF FLOORS LTD.
(Dept. D), Imber Court, E. Molesey, Surrey.
'Phone: EMBERBROOK 3300 (4 lines).
Licensees in principal provinces.

Self-contained VENTILATION & FILTRATION UNITS for A·R·P· shelters

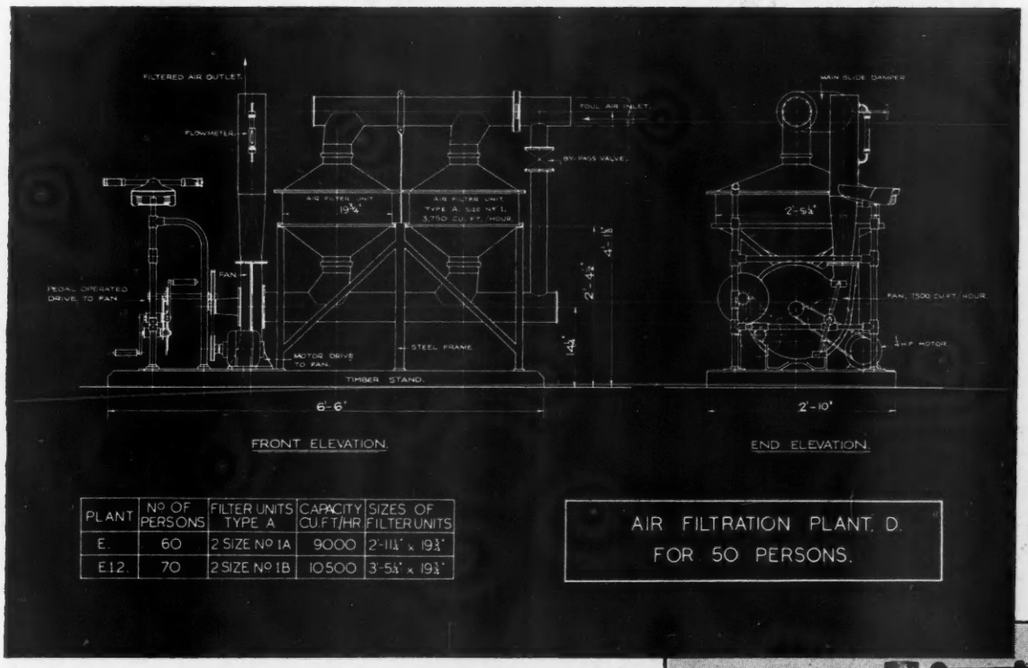
(Tested & approved by the Home Office)

Shelters should be capable of giving protection to as many as the floor area will accommodate, since it is inconceivable that persons would be refused admittance to a shelter which still had space available.

Shelters equipped with ventilation and filtration plants need be no more than one-fourth the size of unventilated shelters for equivalent accommodation. This much reduces the constructional cost per person, and also minimises the size of the target and its vulnerability both to gas and high explosives.

We, as general engineers and the largest manufacturers of activated carbon, have unrivalled experience in the design and equipment of power-operated ventilation and filtration plants, equipped with standby operation by pedal, manual, or other independent means.

We are prepared to co-operate with Architects, Contractors or Ventilating Engineers in the design of plant for specific applications.

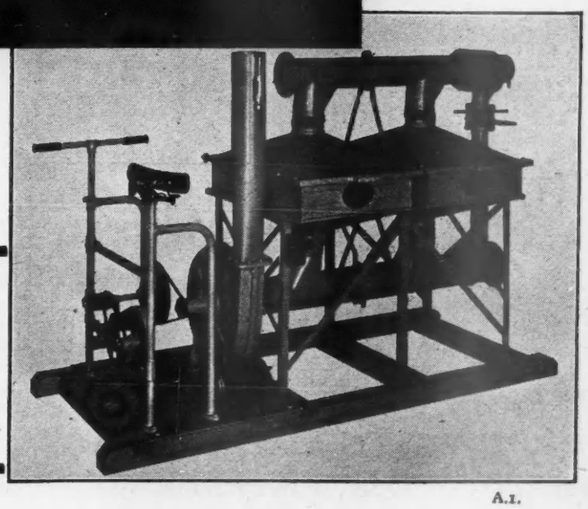


PLANT	No OF PERSONS	FILTER UNITS TYPE A	CAPACITY CU FT/HR	SIZES OF FILTER UNITS
E.	60	2 SIZE No 1A	9000	2'-11¼" x 19¾"
E.12.	70	2 SIZE No 1B	10500	3'-5¼" x 19¾"

AIR FILTRATION PLANT. D.
FOR 50 PERSONS.

Dimensions of Standard Plant for 50 persons

Similar plants have been installed by: English Steel Corporation, Thos. Firth & John Brown, Trollope & Colls, Metropolitan Water Board, Kilverts, Darlington Forge, and leading Gas and Electricity Undertakings, etc.



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AND COMPANY LIMITED
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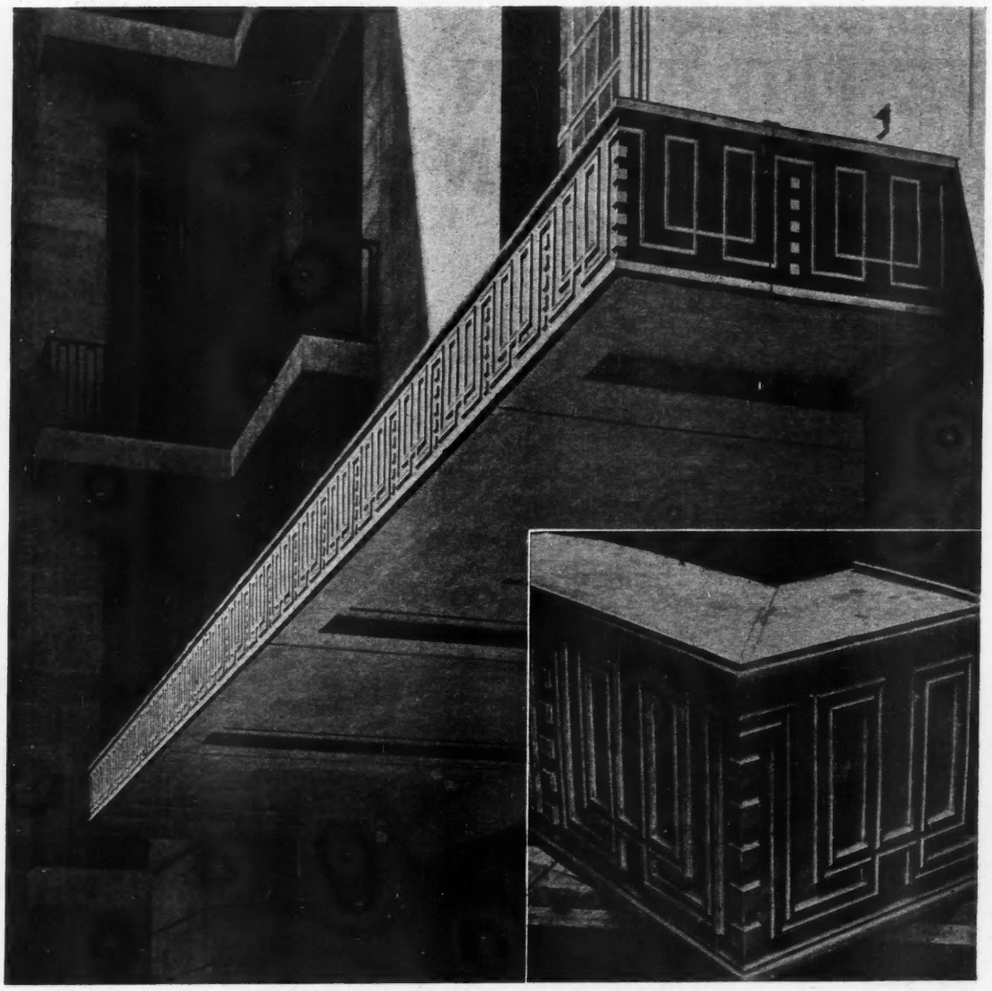
LONDON OFFICE: 66 VICTORIA STREET, S.W.1.

A.1.



Lead fascia to entrance canopy, London University.
Architect: Charles Holden, F.R.I.B.A. Craftsmen: Messrs. Stoner & Saunders Ltd.

Permanence and decorative value

Lead was used for the fascia of this canopy. It is permanent, and lends itself to a great variety of decorative treatments. The ornament in this case is in relief, with a recessed central portion, which has been gilded in order to emphasise the motif.

The small detail photograph shows one of the units assembled on the bench together with the first part of the welted joint.

h
LEAD

A series of Information Sheets (part of the Architects' Journal Library of Planned Information) and Technical Bulletins on the uses of lead in building construction have already been issued. If you do not already receive all technical publications as issued, please write to the Council, who will gladly place your name on their mailing list.

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STOP PRESS. CELLACTITE Sheeting and Ventilators were supplied for Westminster City Council Central Cleansing & Transport Depot, Catliff Road, S.W.1. (Architect: G. Grey Wornum, F.R.I.B.A.) See page 1242.

The photograph on right shows an extensive installation of CELLACTITE Sheeting and Ventilators for Pirelli General Cable Works, Ltd., Eastleigh.

Cellactite & British Uralite Ltd., Lincoln House, 296/302, High Holborn, London, W.C.1. 'Phone: Holborn 5291-2 & 8824. 'Grams: Holb, London. Works: Higham, Kent.

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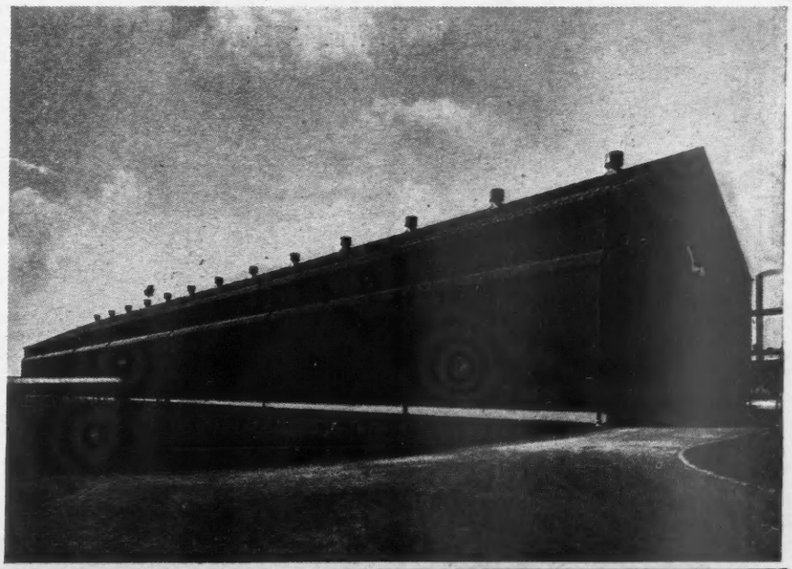

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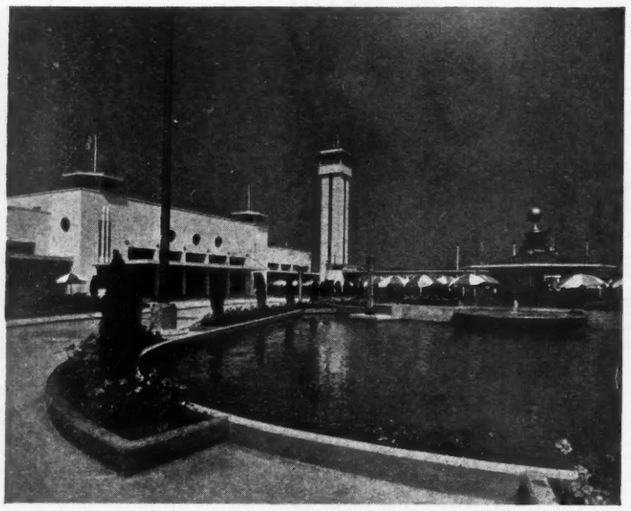
Mr. William H. Hamlyn, F.R.I.B.A., Architect to the L.M.S. Railway.

Illustrated and described on pages 1219 to 1224 of this issue.



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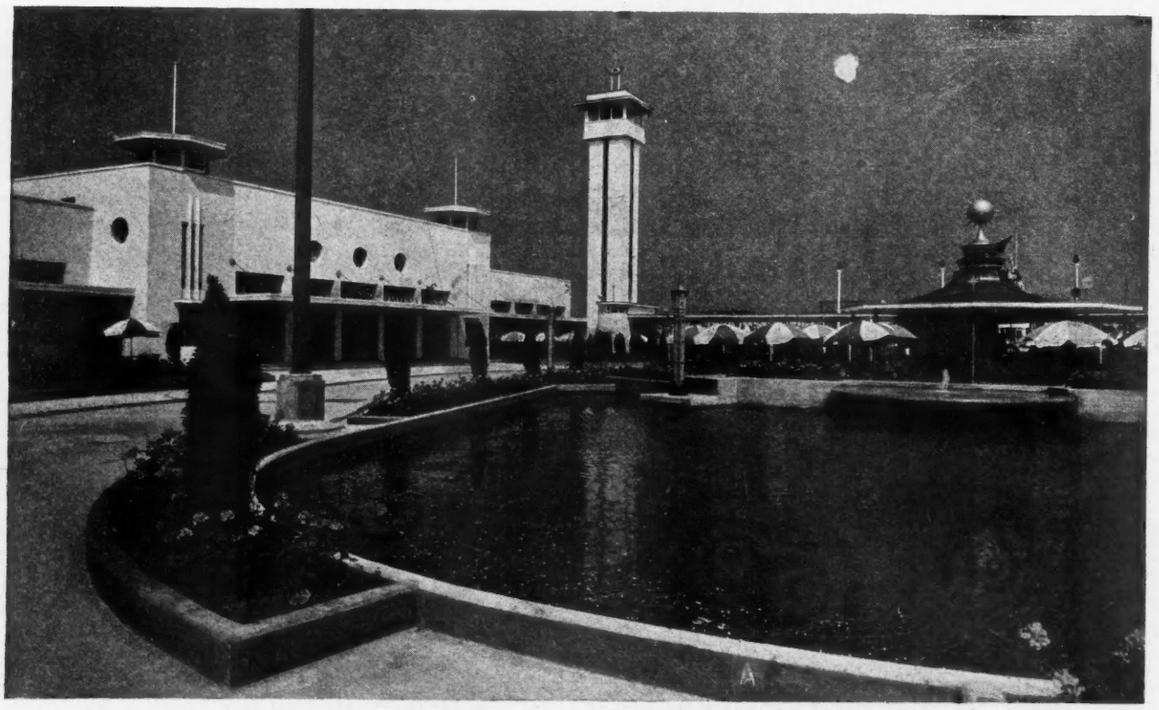
Architect: Mr. WILLIAM H. HAMLYN, F.R.I.B.A.



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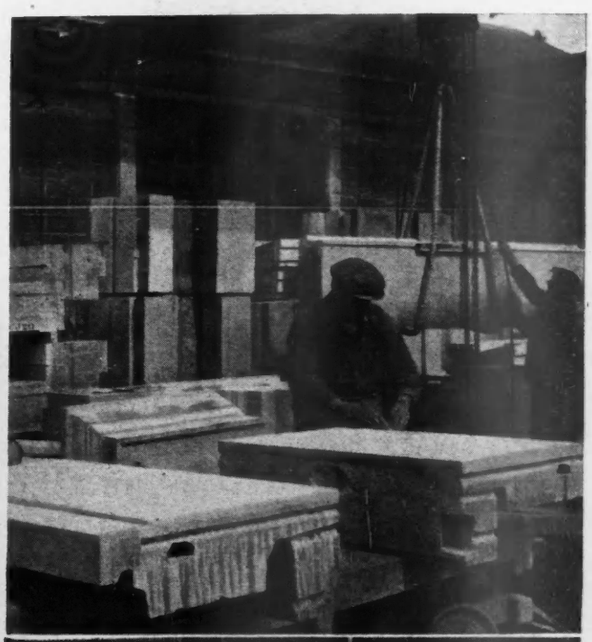
EMPIRE STONE IN THE MAKING: 7



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The finishing of Empire Stone consists of removing the top skin. In some cases this is done by machinery, and the left-hand photograph above shows the machine rubbing of ashlar. The removal of the top skin of cement is a process which involves extra time and labour, but which considerably improves the appearance of the stone.

The photographs on right show a portion of the testing and finishing shops. Note the elaborate work at the back of the stones in the upper photographs. In steel framed construction the stonework is frequently more elaborate at the back than at the front. All stonework is covered with slurry at this stage to keep it clean during handling and fixing.

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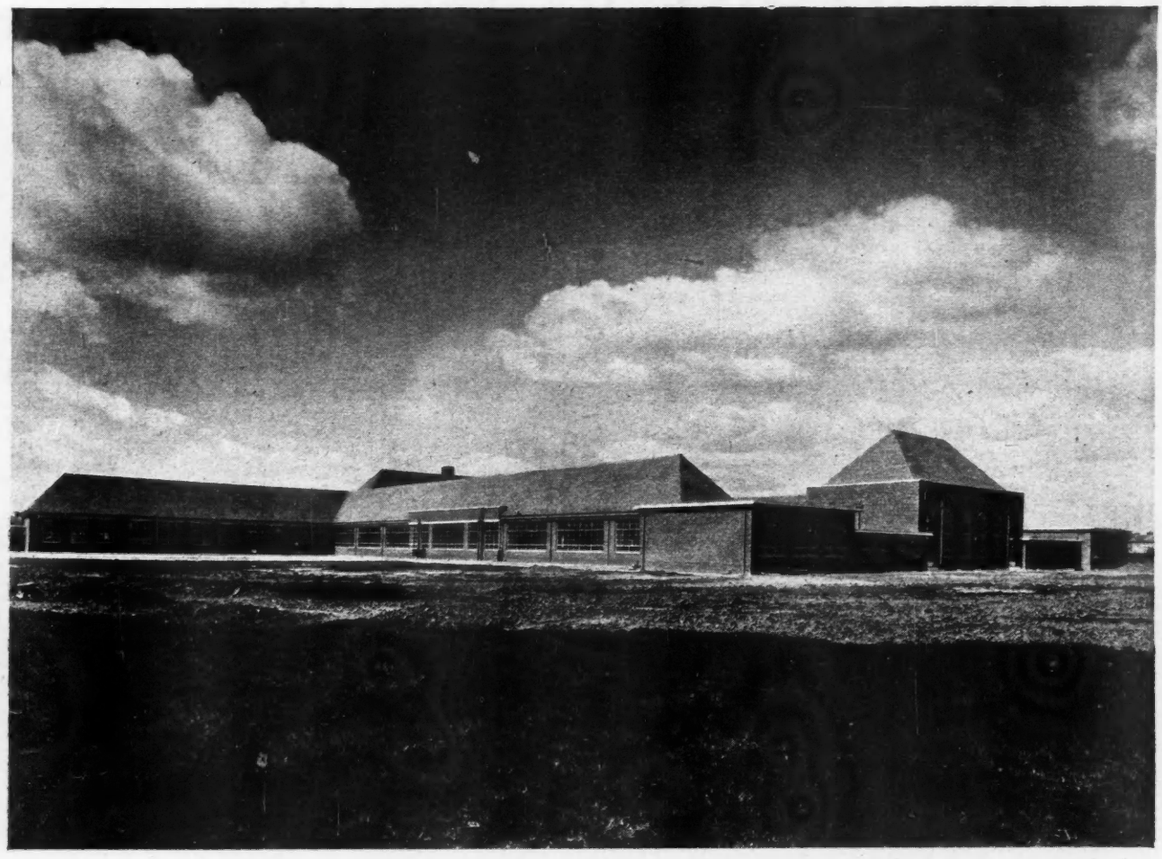

Frank Lee, Esq., L.R.I.B.A., A.M.I.C.E., Architect

Illustrated and described in this issue see pages 1225 to 1229.

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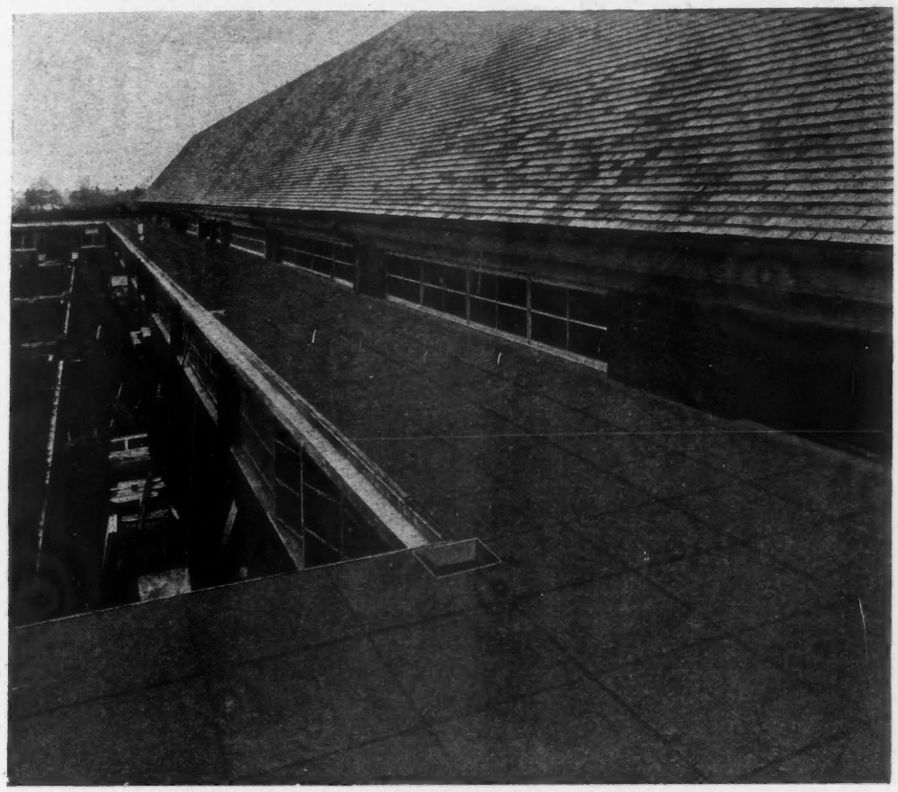

Architect:
Frank Lee, Esq.,
L.R.I.B.A., Assoc.M.Inst.C.E.

at Albany Street School Enfield

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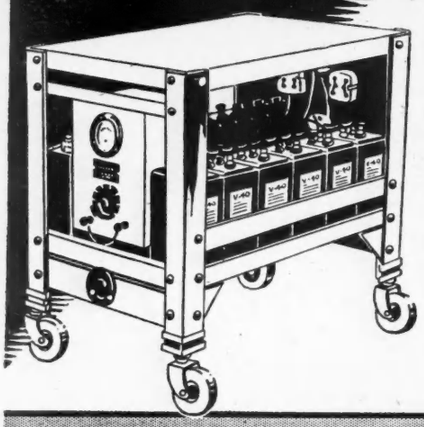

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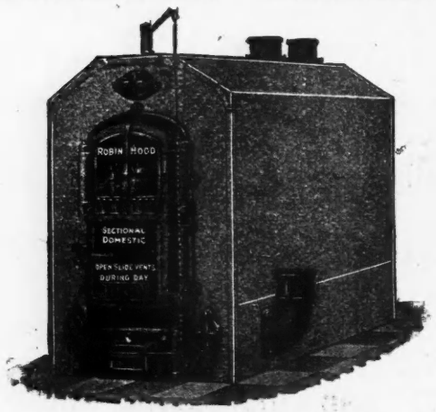

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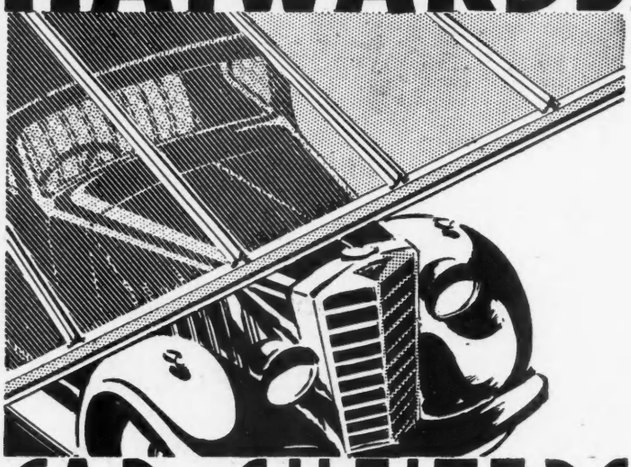

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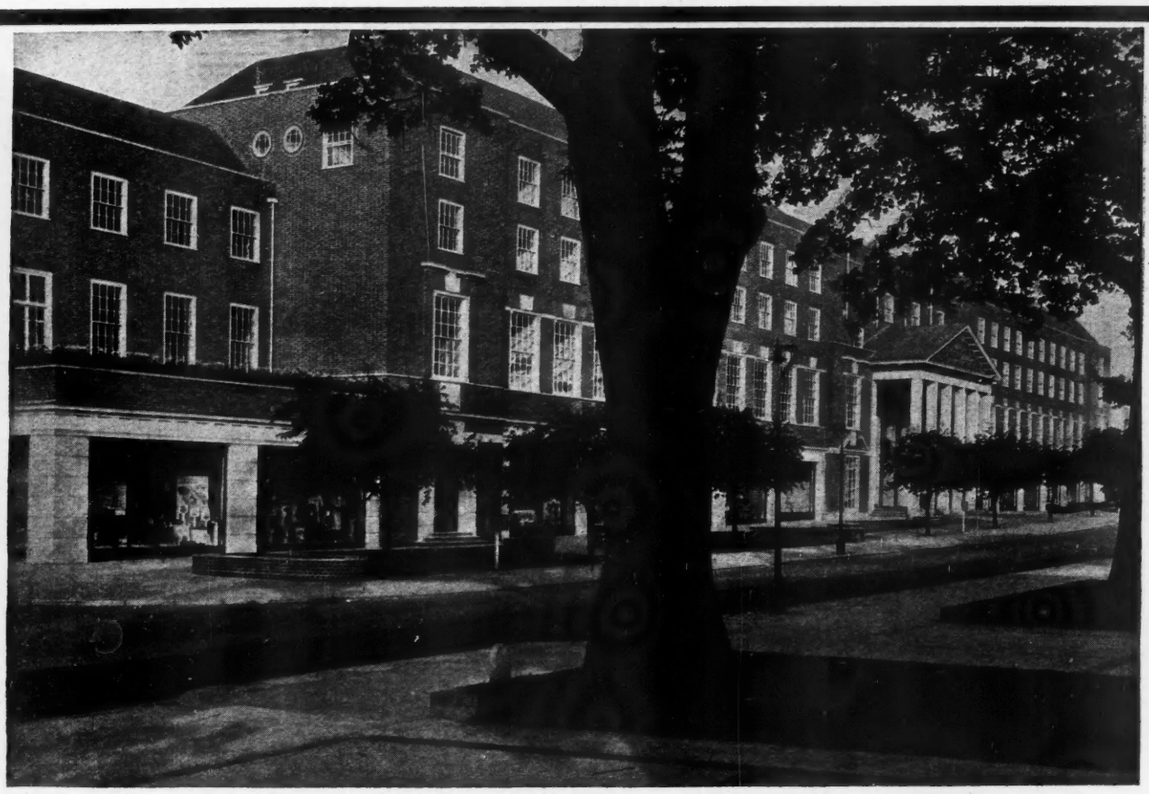

NEW PREMISES FOR WELWYN STORES (1929) LTD.

Architect:
Louis de Soissons, Esq., F.R.I.B.A., S.A.D.G.

For other illustrations and description of this building see pages 1230 to 1232 of this issue.

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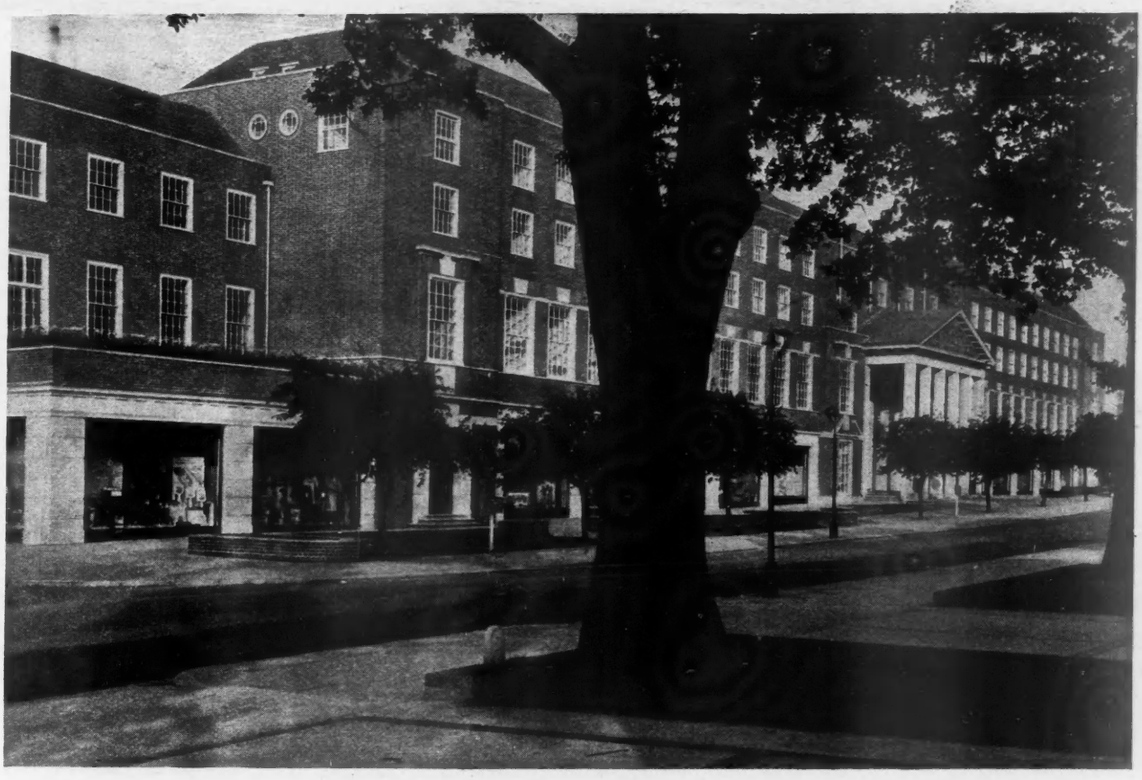

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Architect: Louis de Soissons, Esq., F.R.I.B.A., S.A.D.G.
General Contractors: Welwyn Builders Ltd.

See also pages 1230 to 1232 of this issue for other illustrations and description of this building.

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NATIONAL INSTITUTE OF MEDICAL RESEARCH, Mill Hill, N.W.7.	Architect: Maxwell Ayrton, Esq., F.R.I.B.A.
ROYAL NATIONAL LIFEBOAT INSTITUTION, New Factory, Barnet By-pass.	Architect: H. Kenchington, Esq., F.R.I.B.A.
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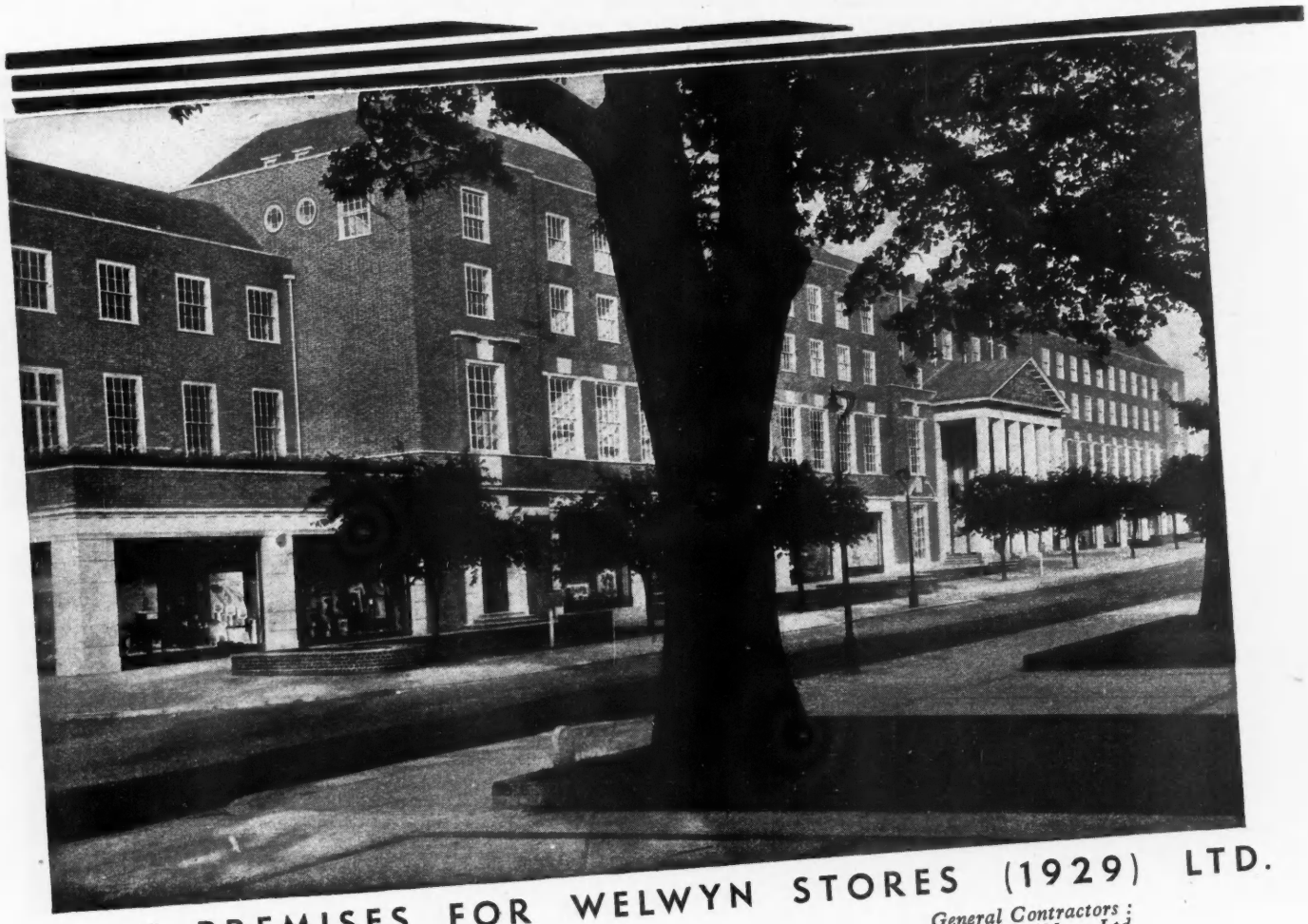

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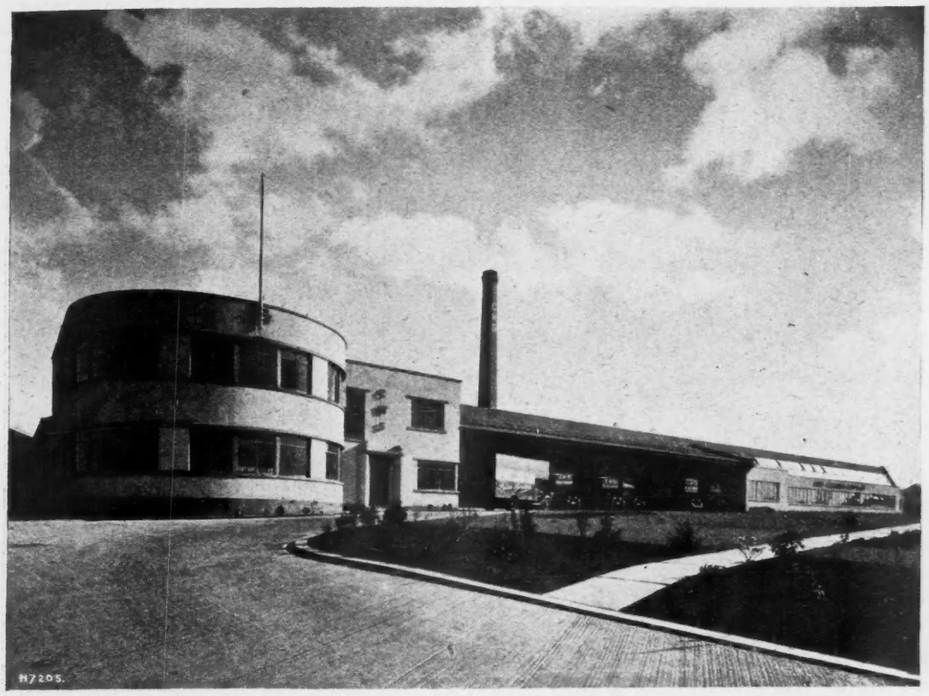

Architect: W. G. Townsend Gray Contractors: C.W.S. Building Dept., Newcastle.

A lovely job—in fact one of the best I have seen. The stucco is "as hard as iron" and of an excellent texture, although that is really only to be expected when

"Adamite" Mixture stucco

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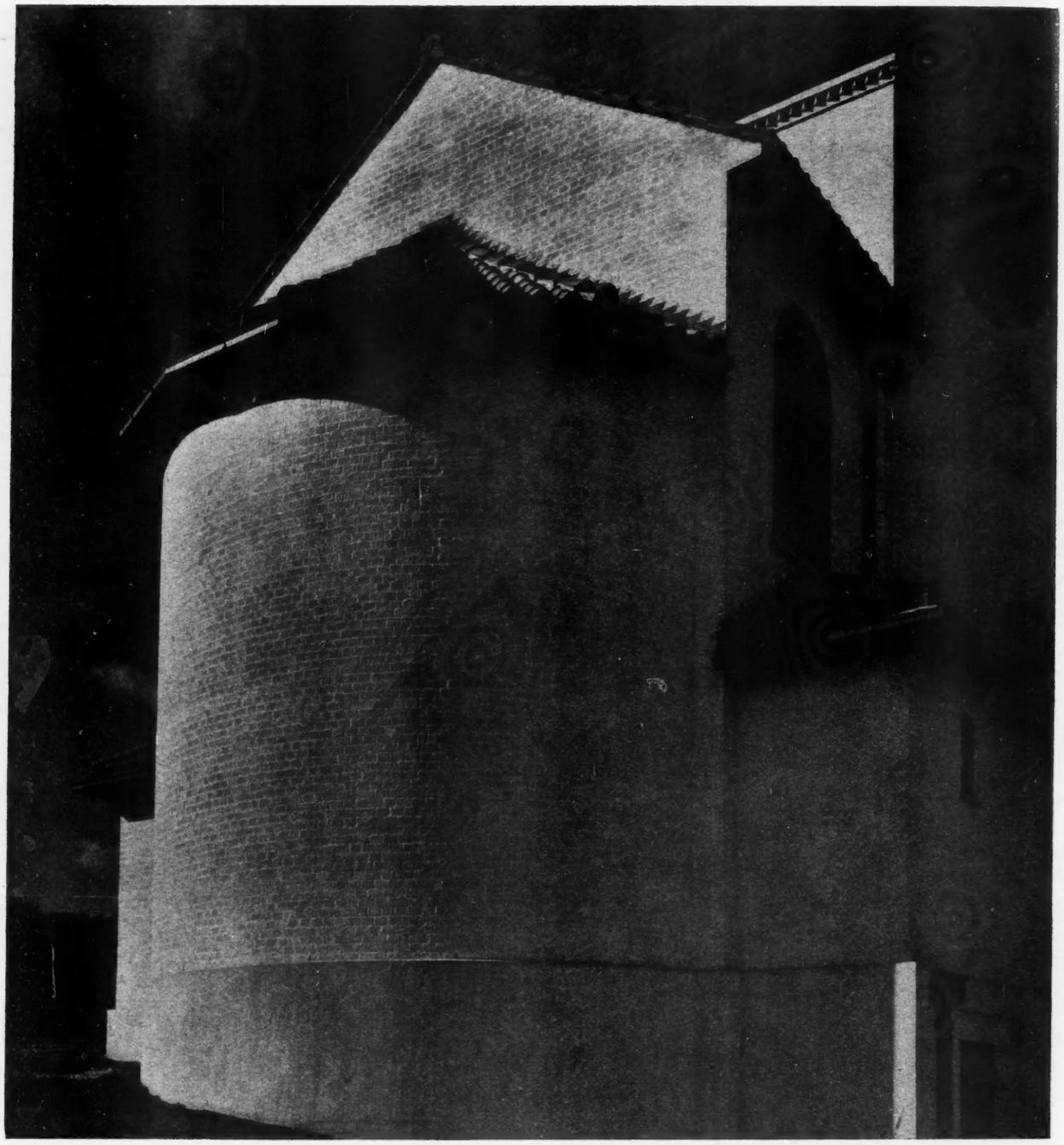

Church of St. Mary and St. George, Sands, HIGH WYCOMBE. 'Phorpres' Rustic bricks limewashed were used inside and out.
Architect: Gerald Wellesley, F.R.I.B.A. and Trenwith Wills, A.R.I.B.A. Contractors: Wm. Hartley & Son, Wexham, Slough, Bucks.

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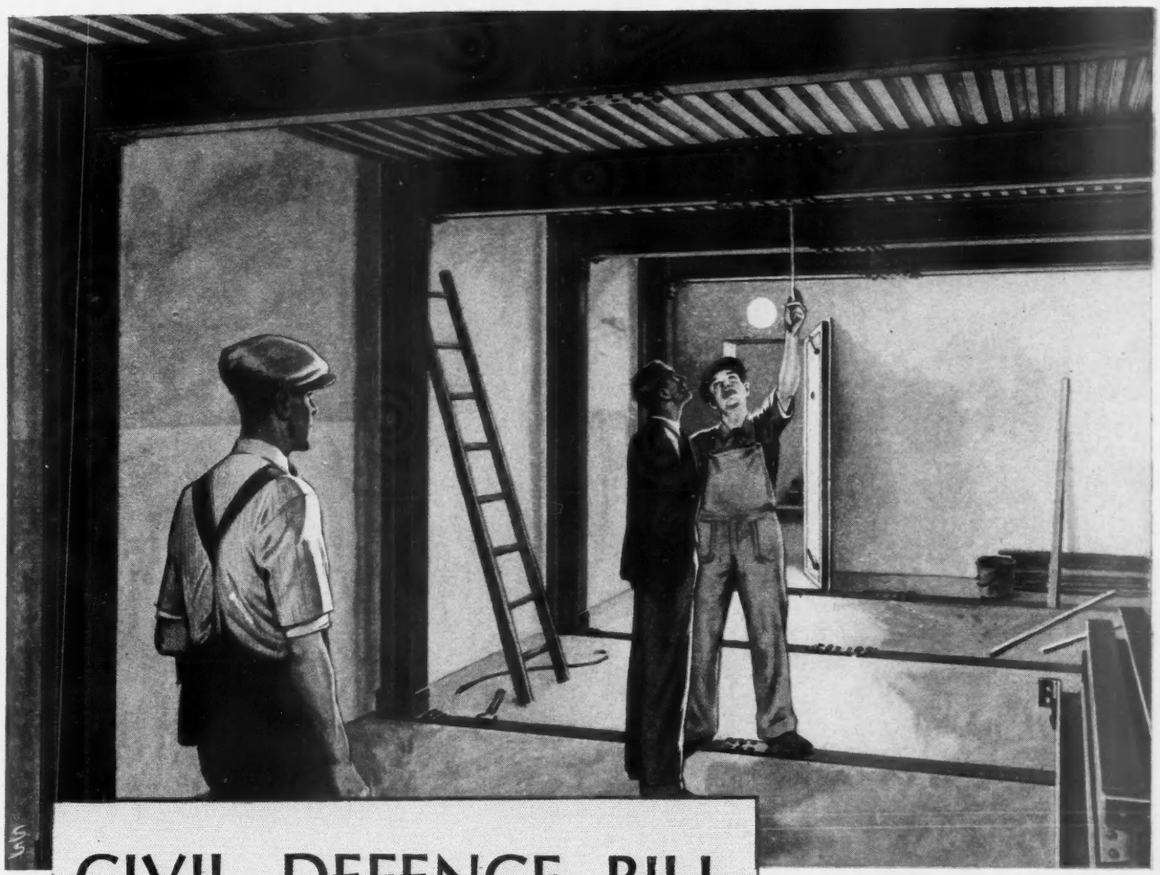

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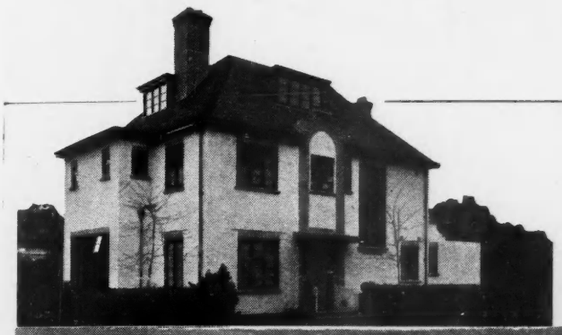

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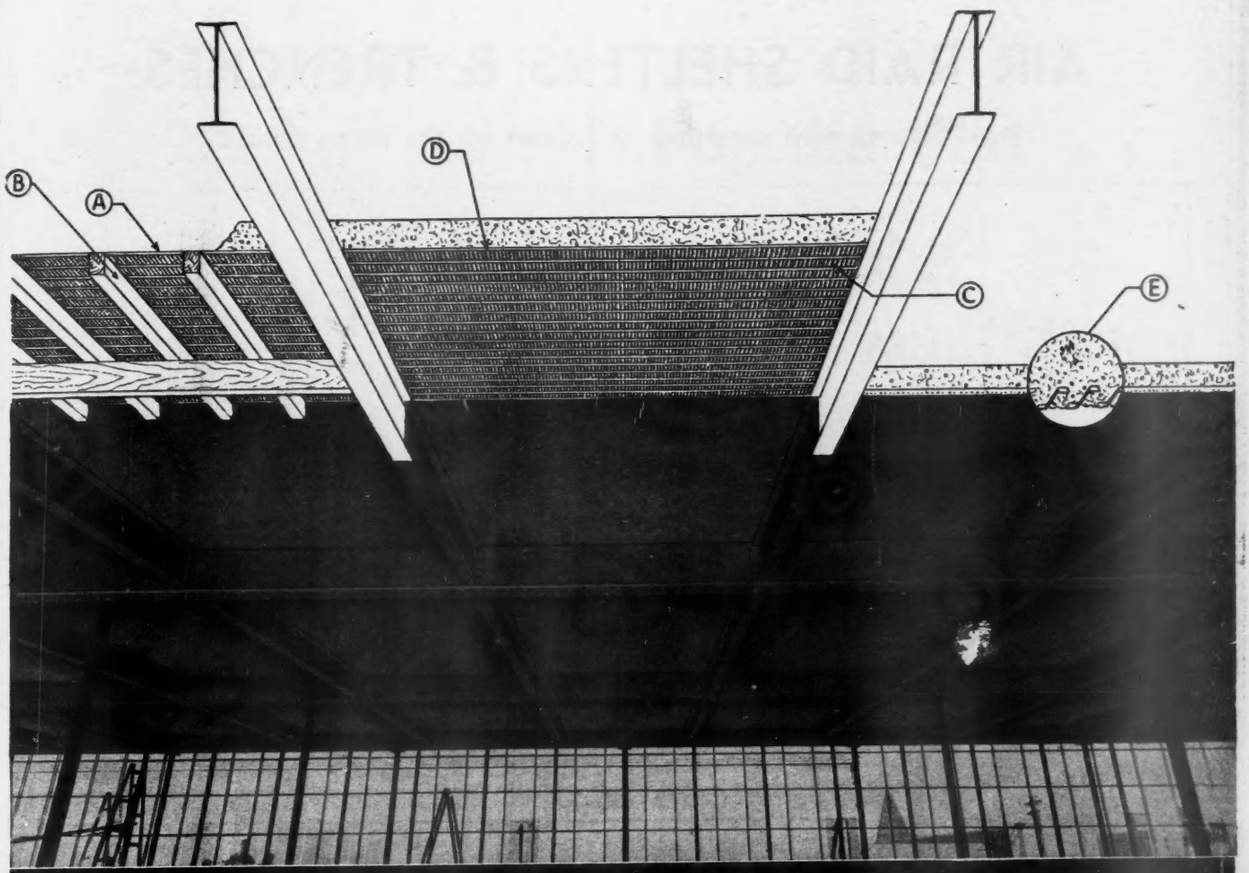

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By eliminating the use of close boarded shuttering during construction Hy-Rib cuts out one complete labour process. The saving in labour, material and time is considerable. The Hy-Rib sheets perform the dual purpose of supporting the concrete slab whilst it is being poured and acting as the reinforcement for the finished slab, thereby permitting the operation of centering the concrete and laying the reinforcement to be carried out simultaneously. Hy-Rib is a reinforcement which can be laid with the certainty that it will remain in position at the bottom of the slab where the maximum reinforcing value is developed, thereby providing a guarantee of safety. Hy-Rib provides on the soffit of the finished slab a ready "keyed" surface to receive the ceiling plaster, and no hacking or other treatment is necessary after the temporary timbers have been dismantled.

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B. Wood bearers only required during the concreting operation.

C. Keyed formation of Hy-Rib mesh provides a soffit with an exceptionally tenacious bond for the plaster and eliminates the danger of falling ceilings.

D. Hy-Rib is the reinforcement for the concrete. It cannot "ride up" into the concrete when the slab is poured or be displaced. *Hy-Rib is a guarantee of maximum reinforcement efficiency.*

E. "Mechanical bond" between steel reinforcement and concrete is provided by the teeth of the Hy-Rib mesh to distribute the stresses evenly throughout the slab.

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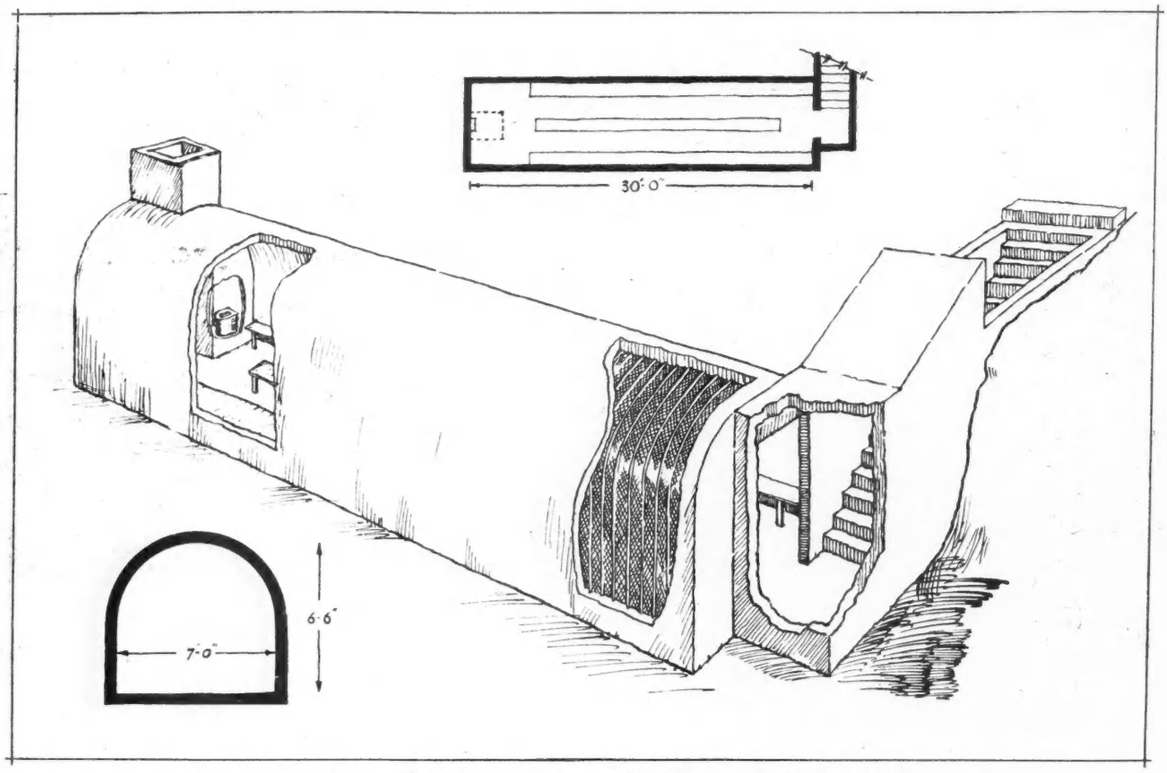

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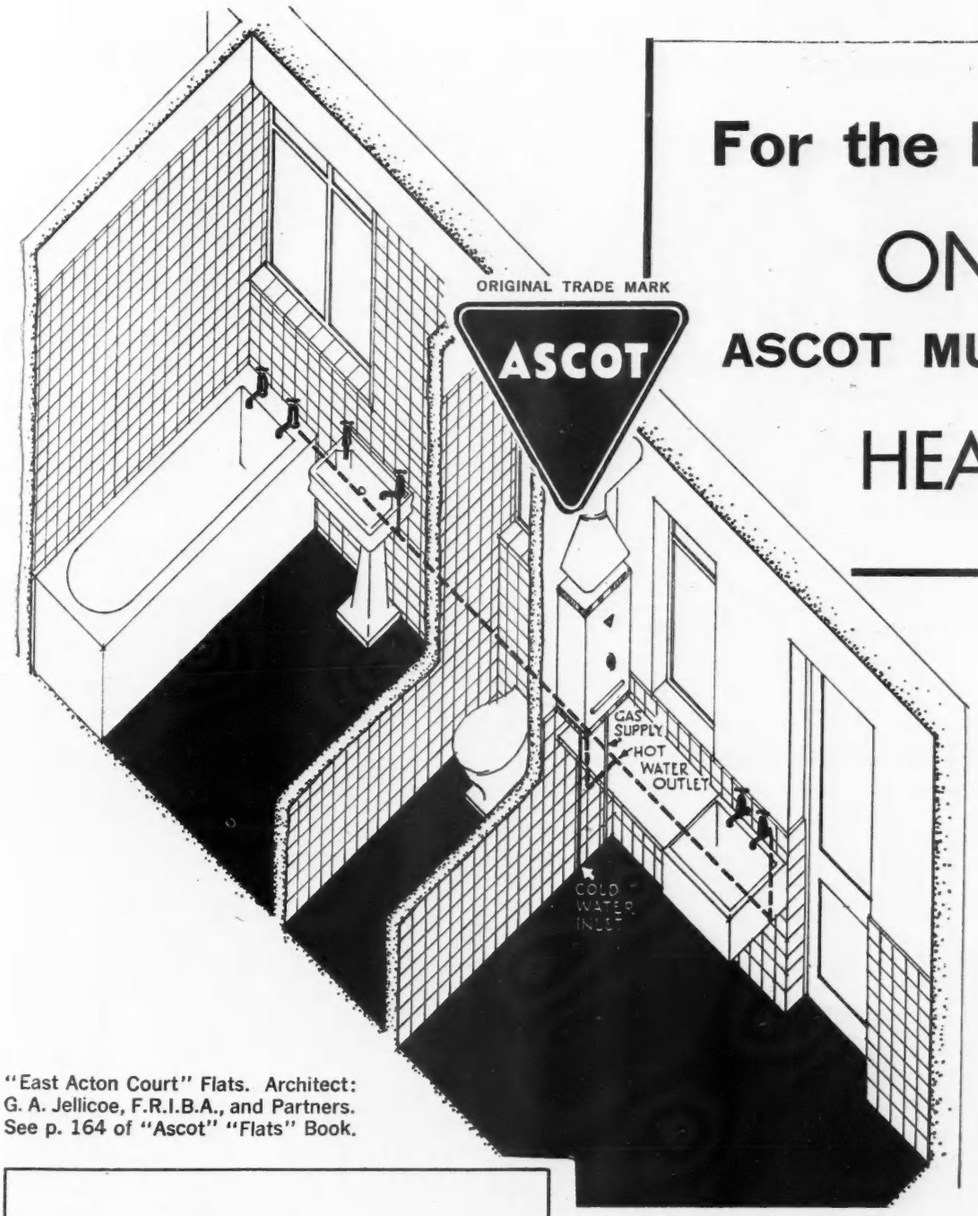
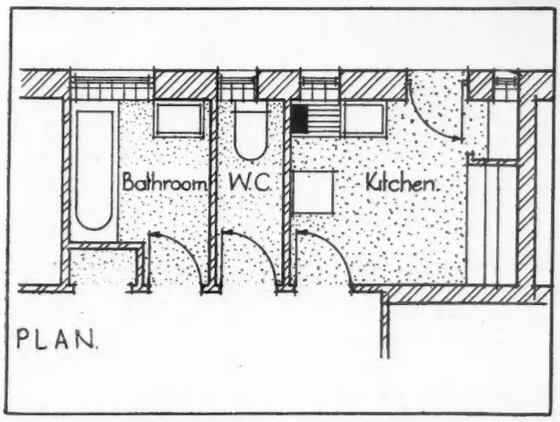


"East Acton Court" Flats. Architect: G. A. Jellicoe, F.R.I.B.A., and Partners. See p. 164 of "Ascot" "Flats" Book.



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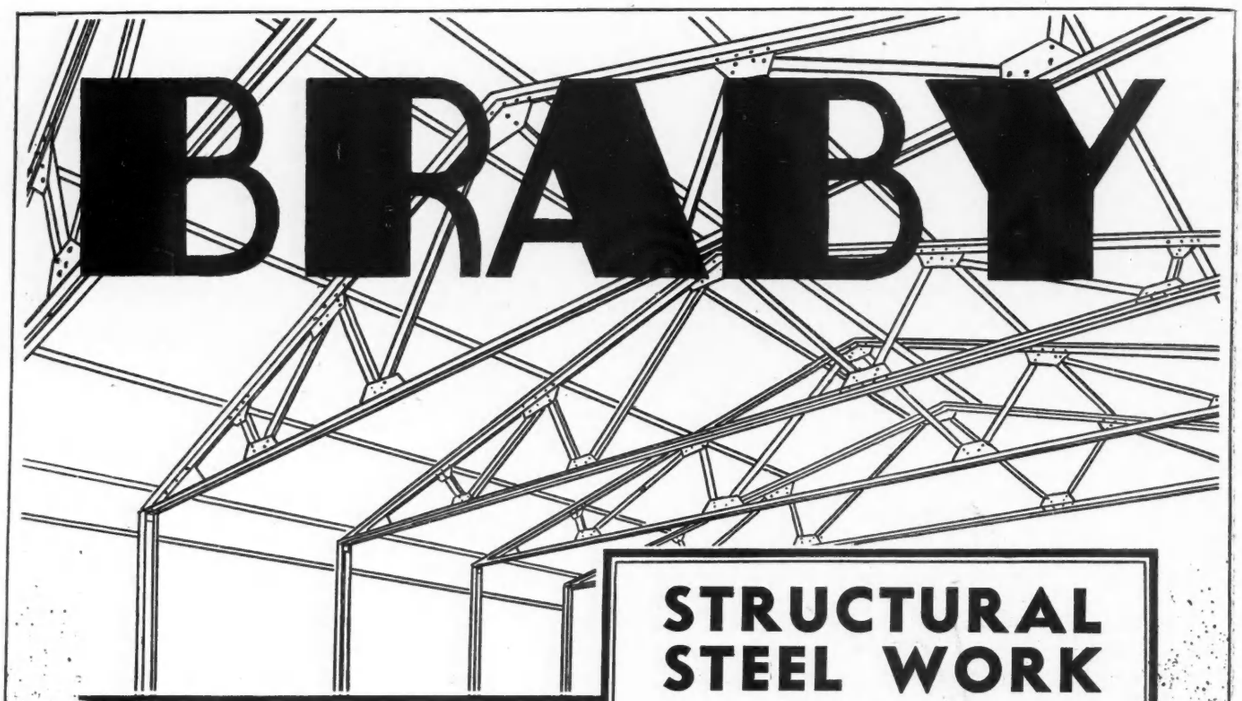

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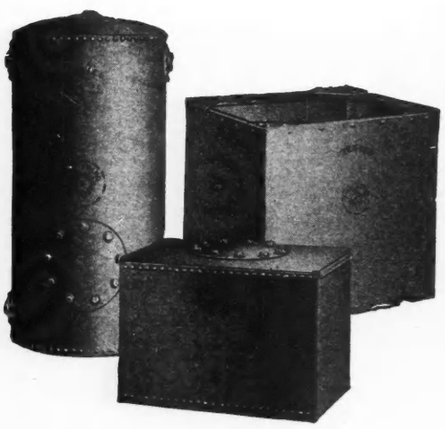

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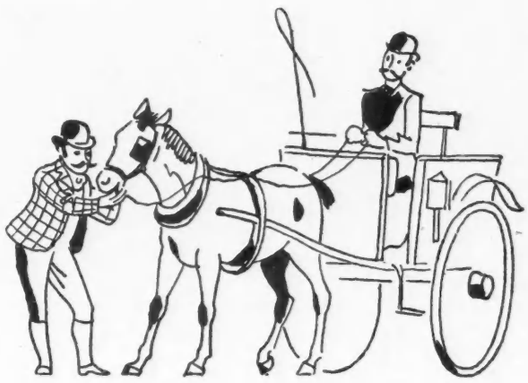

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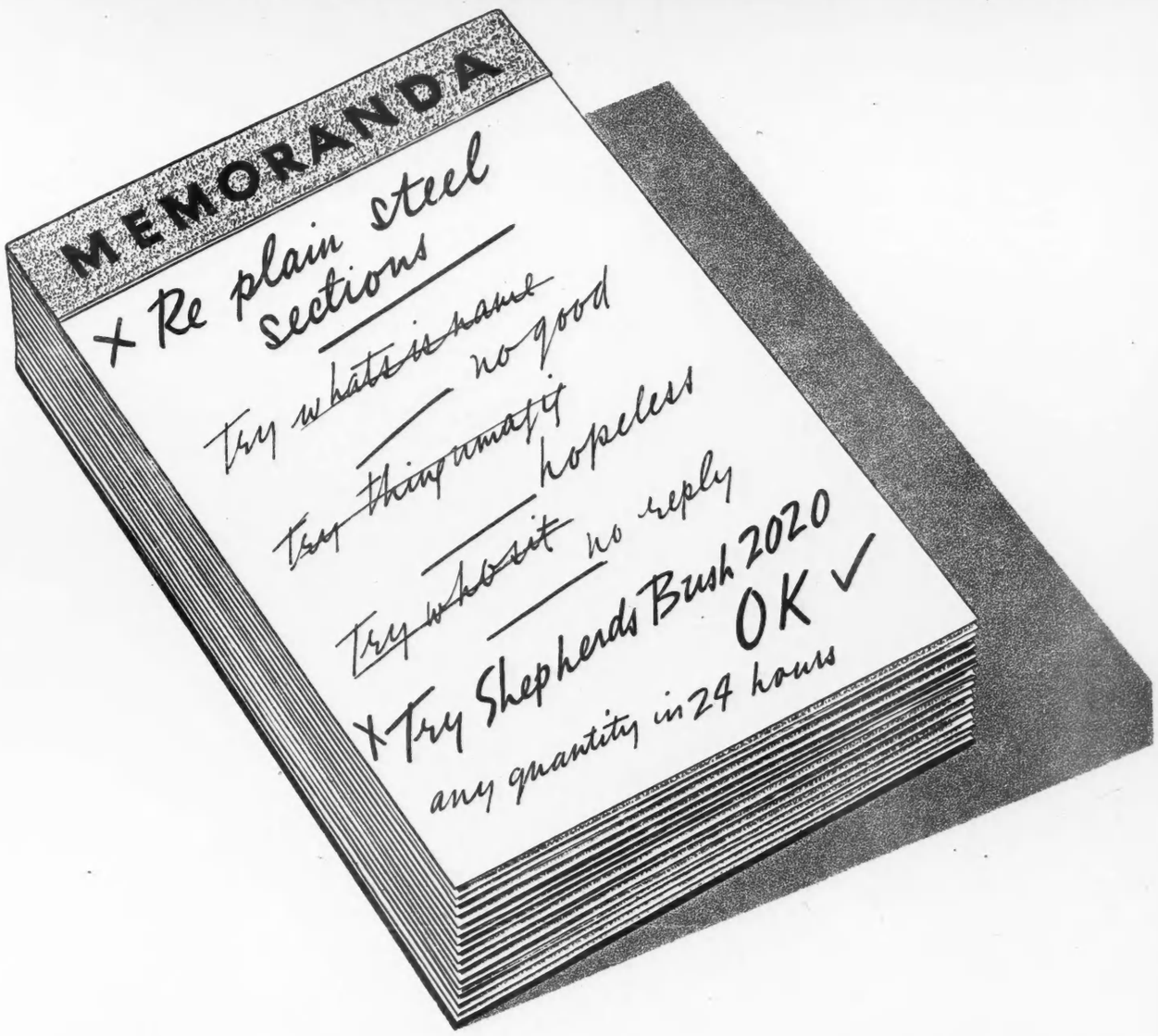

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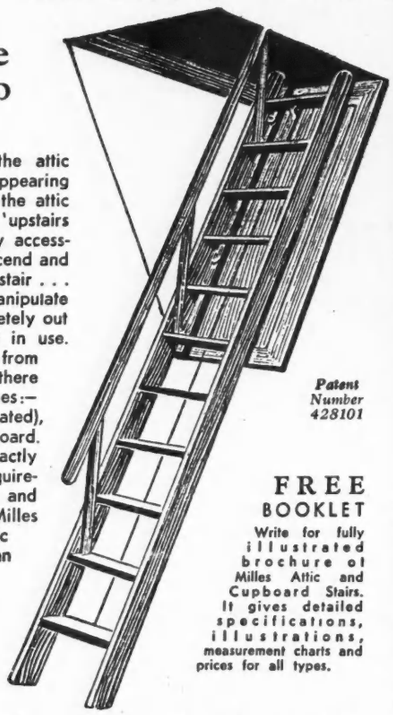

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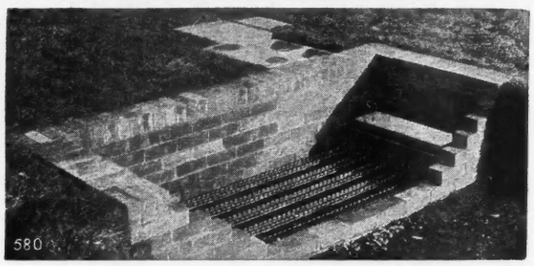

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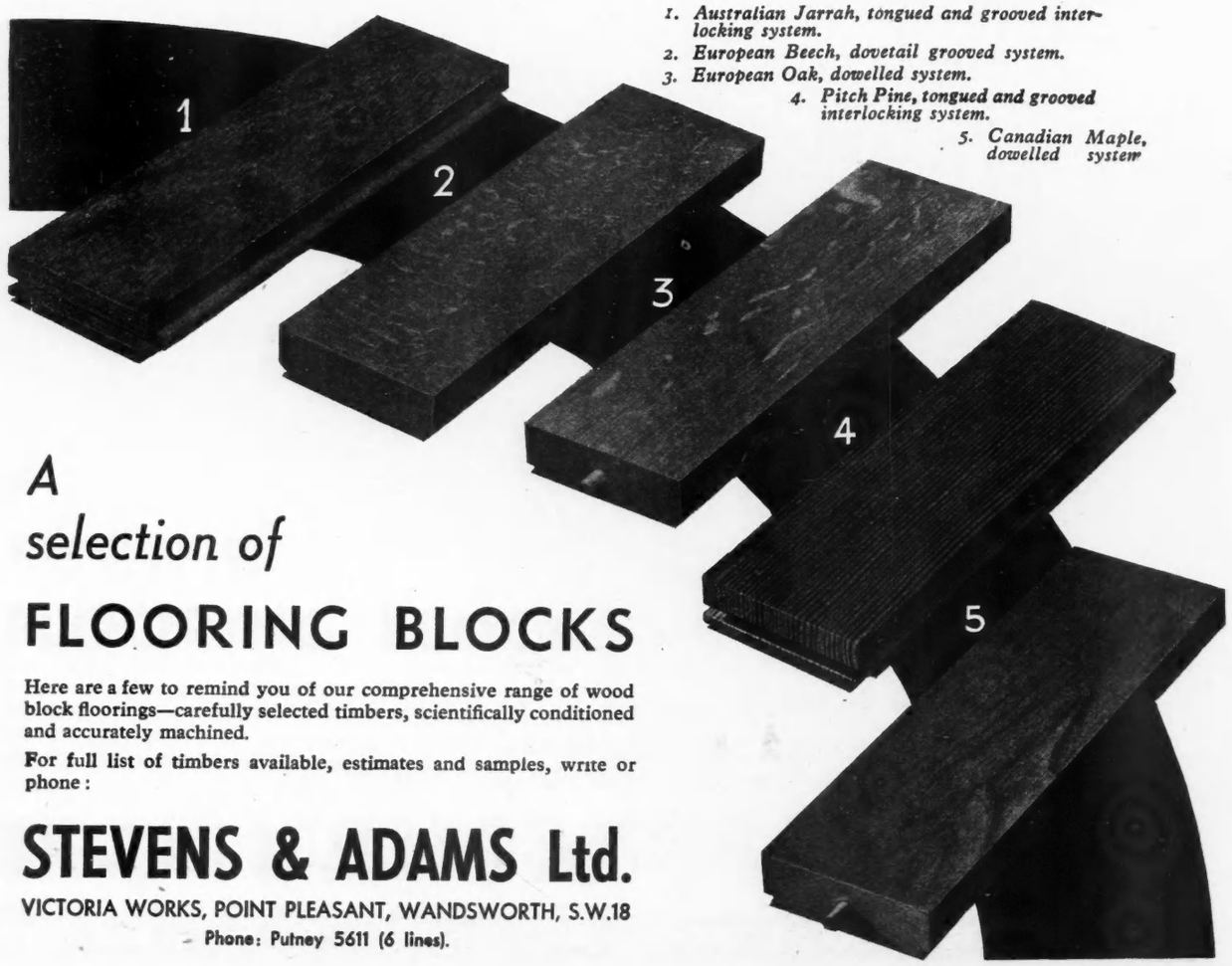

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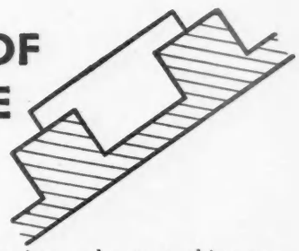

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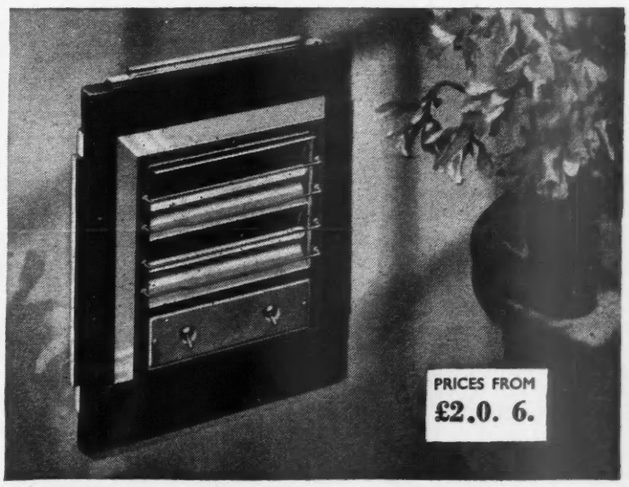

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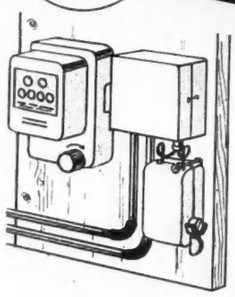

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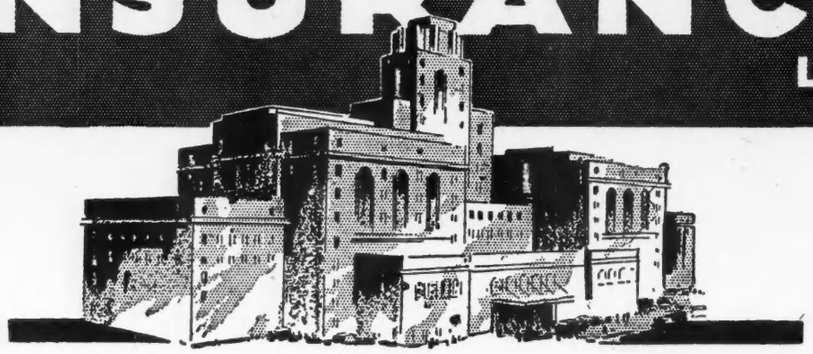

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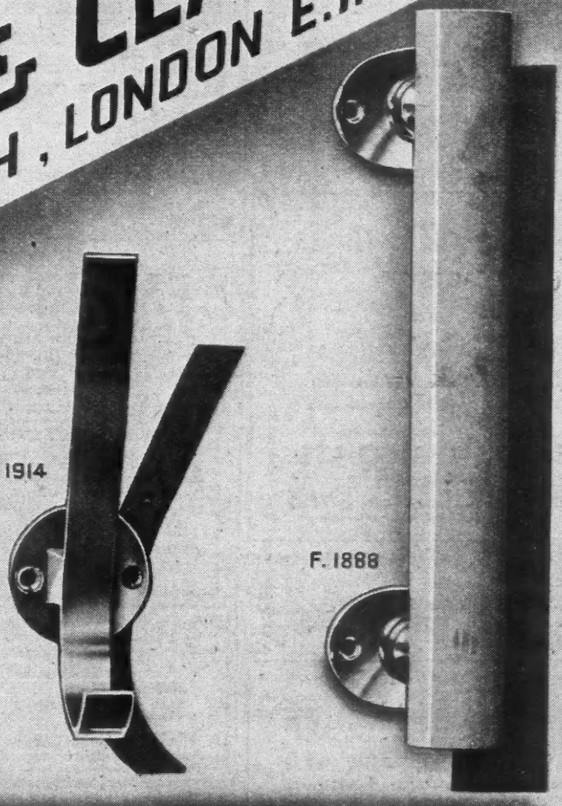

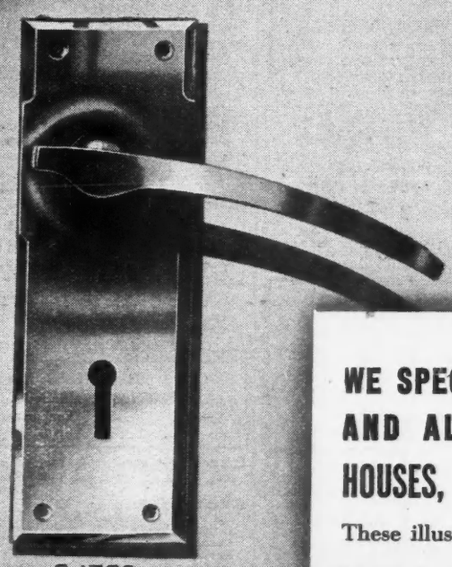

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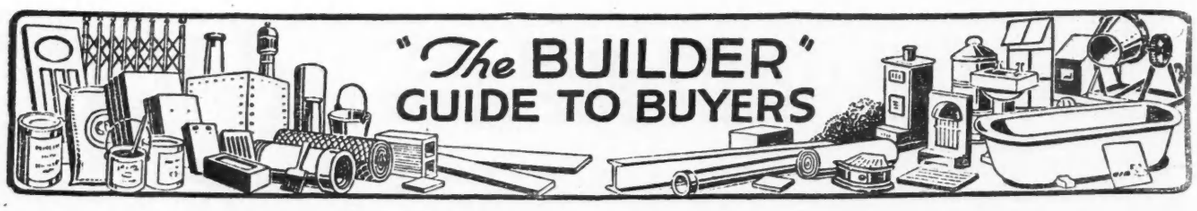

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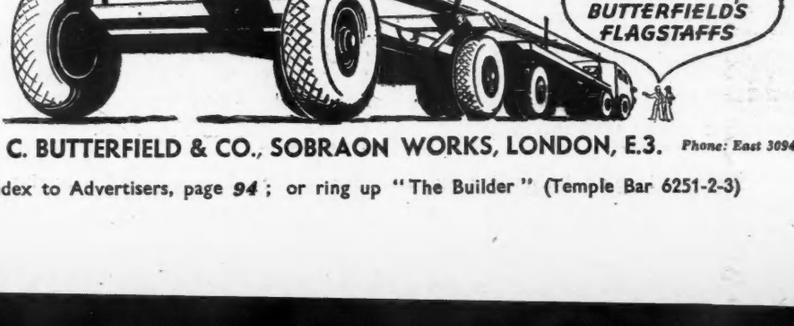

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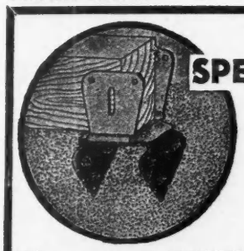

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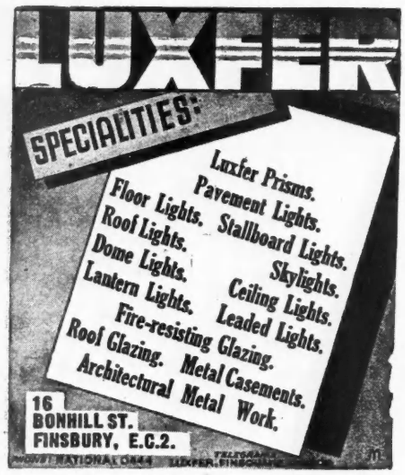

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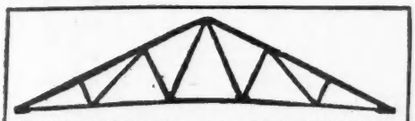

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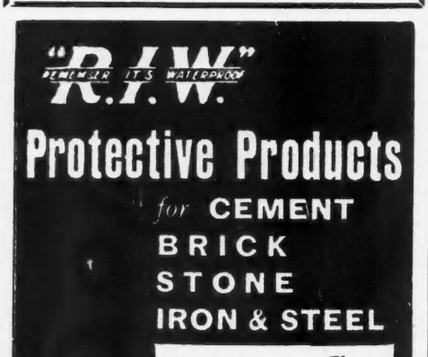

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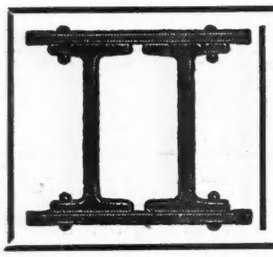
Where no Address is given, see Index to Advertisers, page 94; or ring up "The Builder" (Temple Bar 6251-2-3)



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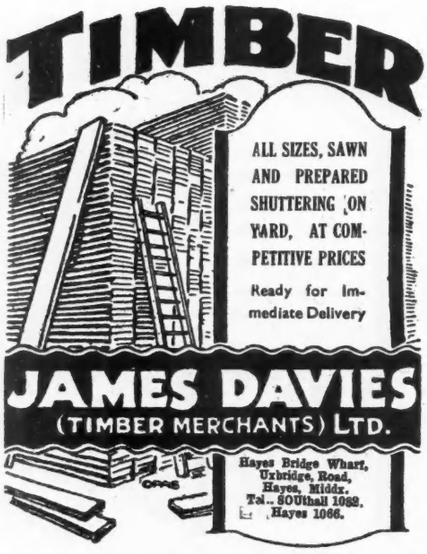
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CITY OF PETERBOROUGH.

ERECTION OF 62 HOUSES ON THE PARK-LANE ESTATE.

The PETERBOROUGH CITY COUNCIL invite TENDERS for the ERECTION of 62 HOUSES on the PARK-LANE ESTATE.

The Houses are in five types, with one, two, three, four, and six bedrooms.

Plans, Specification, Conditions of Contract and Forms of Tender may be obtained from the City Engineer upon payment of a deposit of £2, which will be returned on receipt of a bona-fide Tender.

Tenders, enclosed in the special envelopes provided, endorsed "Tender for 62 Houses on the Park-lane Estate," must be delivered to the undersigned not later than Noon on MONDAY, the 10th JULY, 1939.

ARTHUR J. REEVES,
Town Clerk.

Town Hall,
Peterborough,
20th June, 1939.

NORFOLK COUNTY COUNCIL.

MUNDESLEY AREA SCHOOL: EXTENSIONS.

The EDUCATION COMMITTEE is prepared to receive TENDERS for the ERECTION of ADDITIONS to the above-named SCHOOL, comprising Two Classrooms and Cloakroom to the existing School, and NEW BLOCK containing Assembly Hall, Three Classrooms, Cloakrooms, Offices, Staff Rooms, Kitchen, etc.

Contractors desirous of tendering should forward their names and addresses to the undersigned on or before Monday, 10th July, 1939. Applications must be accompanied by a deposit cheque of Two Guineas made payable to the "Norfolk Education Committee," the deposit being returned on receipt of a bona-fide Tender.

Plans and Conditions of Contract may be seen at the office of the Committee's Architect, Mr. F. G. Limmer, F.R.I.B.A., on and after Saturday, 15th July, 1939, upon which date Bills of Quantities will be posted.

Sealed Tenders are to be sent in the official envelope and to be delivered to the Clerk of the Council, County Offices, Thorpe-road, Norwich, not later than 12 noon on THURSDAY, 27th JULY, 1939. No pledge is given to accept the lowest or any Tender.

The Contractor whose Tender is accepted will be required to accept the Fair Wages Clause and, as far as practicable, to employ workmen resident in the neighbourhood of the work.

H. MOORE,
Secretary to the Education Committee.

Stracey-road,
Norwich.
June, 1939.

COUNTY BOROUGH OF HALIFAX.

HOUSING COMMITTEE.

15 HOUSES AND SHOPS.

NURSERY-LANE.

TENDERS are invited in connection with the above-mentioned Scheme for the following (separate or combined) trades:—

EXCAVATOR, MASON and BRICKLAYER.
CARPENTER and JOINER.
PLUMBER and GLAZIER.
PLASTERER.
SLATER.
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Contractors will be required to tender on a LUMP-SUM BASIS on Specification and Plans only (Bills of Quantities will not be provided).

The Plans, Specifications and full particulars as to the mode of tendering, etc., may be obtained on and after Thursday, 22nd June, 1939, at the office of the Borough Engineer, Crossley-street, Halifax, on payment of a deposit of Two Guineas (cheques to be made payable to the "Halifax Corporation"), which will be returned on receipt of a bona-fide Tender.

Tenders, endorsed as directed in the particulars supplied, must be delivered to the undersigned not later than first post, MONDAY, 10th JULY, 1939.

Contractors should state when tendering whether or not they are on the King's Roll and will be required to observe the Fair Contracts Clauses adopted by the Corporation, and the regulations of the Ministry of Health as regards the employment of apprentices.

The Committee does not bind itself to accept the lowest or any Tender.

PERCY SAUNDERS,
Town Clerk.

Town Hall,
Halifax.
16th June, 1939

COUNTY MENTAL HOSPITAL, RAINHILL.

TENDERS are invited by the COMMITTEE OF VISITORS for RUBBER TILING for the Corridors in the new ADMISSION HOSPITAL, from Firms making and laying their own Materials.

Quantities may be obtained from the Clerk to the Visiting Committee, T. Garner, Esq., 49, Corporation-street, St. Helens, Lancs—on payment of a deposit for £2 2s., which will be returned on the receipt of a bona-fide Tender.

Tenders to be sent through the post to the Clerk to the Committee of Visitors, County Mental Hospital, Rainhill, Lancs, in the envelope provided, and must not bear any mark or name indicating the sender, and be received not later than 9 a.m. on SATURDAY, the 22nd JULY, 1939.

The Committee do not bind themselves to accept the lowest or any Tender.

W. E. BIXTER,
Clerk and Steward.

21st June, 1939.

BOROUGH OF DAGENHAM.

CENTRAL DEPOT, RAINHAM-ROAD, DAGENHAM.

TENDERS are invited for the CONSTRUCTION of a CENTRAL DEPOT, comprising the erection of Workshop and Timber Stores, Stores, Offices, Mess Room, and A.R.P. Block, Garage and Stables and Cart Shed, and other works incidental thereto, at the Site of the existing Salvage Plant, Rainham-road, Dagenham.

Bills of Quantities and Tender documents may be obtained and plans inspected at the Offices of Messrs. F. J. Clevely & Partner, Quantity Surveyors, 47, Gordon-square, London, W.C.1, and Mr. F. C. Lloyd, A.M.Inst.C.E., Borough Engineer and Surveyor, Civic Centre, Dagenham, on payment of a deposit of £5 5s., which will be returned on receipt of a bona-fide Tender.

Tenders, in sealed envelopes, endorsed "Central Depot, Rainham-road," and bearing no external indication of the identity of the sender, must be delivered to the undersigned not later than 12 o'clock mid-day on MONDAY, 10th JULY, 1939.

The Council do not bind themselves to accept the lowest or any Tender.

F. W. ALLEN,
Town Clerk.

Civic Centre,
Dagenham, Essex,
21st June, 1939.

BE UP TO DATE

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WHITLEY AND MONKSEATON URBAN DISTRICT COUNCIL.

PROPOSED MUNICIPAL OFFICES.

The COUNCIL invite TENDERS for the above WORK, in accordance with the Drawings and Specification and Bill of Quantities prepared by Messrs. Cordingley & McIntyre, F./A.R.I.B.A., Chartered Architects, The College, Durham.

Applications, in writing, accompanied by a deposit of Two Guineas (£2 2s.) for the General Conditions, Bills of Quantities, Form of Tender, etc., should be made to the Architects. The deposit must be by cheque made payable to the Whitley and Monkseaton Urban District Council, which will be returned if a bona-fide Tender is received, and all documents are returned to the Architects.

No Tender will be received unless it is enclosed in a plain sealed envelope endorsed "Tender for Whitley and Monkseaton Municipal Offices," and it must be delivered to me at the undermentioned address not later than first post on MONDAY, 24th JULY, 1939.

The Contractor whose Tender is accepted will be required to enter into a Contract and Bond to the satisfaction of the Council for the due performance of the work, and any Tender accepted will be subject to the approval of the Ministry of Health.

The Council do not bind themselves to accept the lowest or any Tender, and all Contractors tendering must do so at their own expense.

ARTHUR S. RUDDOCK,
Clerk to the Council.

Council Offices,
Whitley Bay.
16th June, 1939

CORPORATION OF WIMBLEDON.

ELECTRICITY DEPARTMENT.

TENDERS are invited for the ERECTION of an above-ground ELECTRICITY SUB-STATION in WRIGHT'S-ALLEY, SOUTHSIDE, WIMBLEDON COMMON.

Form of Tender, Specification and Drawings may be obtained on application to the Chief Engineer and Manager, Electricity House, Durnsford-road, Wimbledon, S.W.19.

Tenders should be enclosed in plain sealed envelopes endorsed "Tender for Sub-Station Building," and addressed to the Chairman of the Electricity Committee, Town Clerk's Office, Town Hall, Wimbledon, and must be delivered not later than 12 noon on WEDNESDAY, 12th JULY, 1939.

The Corporation does not bind itself to accept any or the lowest Tender.

H. EMERSON SMITH, LL.B.,
Town Clerk.

Town Hall,
Wimbledon.
15th June, 1939.

FLINTSHIRE EDUCATION COMMITTEE.

TENDERS are invited for PROVIDING and FIXING CURTAINS and RUNNERS to the STAGE at each of the following SCHOOLS in the COUNTY OF FLINT:—

RHYL COUNTY SCHOOL,
HAWARDEN COUNTY SCHOOL,
HOLYWELL COUNTY SCHOOL,
MOLD CENTRAL SCHOOL.

Particulars may be obtained from the undersigned and Tenders to be submitted by not later than first post on 11th JULY, 1939.

R. G. WHITLEY, L.R.I.B.A., A.M.I.C.E.,
County Architect and Surveyor.

County Buildings,
Mold.

(*Continued on page 82.*)

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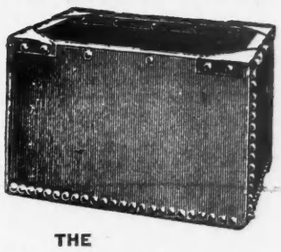

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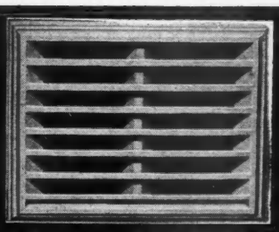

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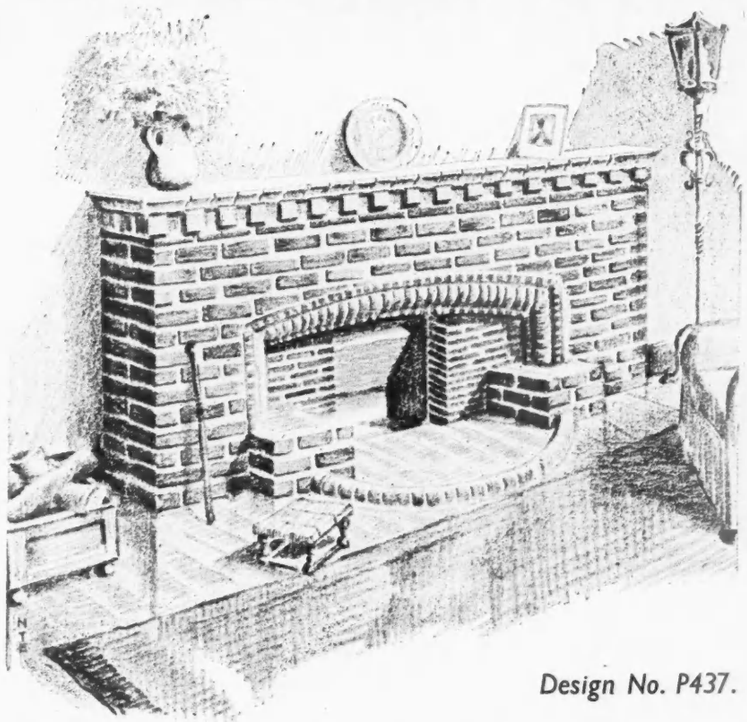

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Member Scientific Instrument Mfrs. Assn. of Gt. Britain

CONTRACTS—*continued*

CITY OF MANCHESTER.

HOUSING ACT, 1936.

The HOUSING COMMITTEE are prepared to receive TENDERS for the ERECTION of the following RESIDENTIAL FLATS and ANCILLARY BUILDINGS :—
235 RESIDENTIAL FLATS at HULME.
181 RESIDENTIAL FLATS, 8 SHOPS and 4 GARAGES at COLLYHURST (Contract No. 4).

The Bills of Quantities, General Conditions and Tender Forms in connection with the above schemes will be available on and after the 5th July 1939, and will be supplied on production of the receipt for deposit of Two Guineas for each scheme with the City Treasurer.

The deposit will be refunded on the submission of bona-fide Tenders and the return of the documents.

Tenders, which must be enclosed in the official envelope provided for the purpose and sealed, should be addressed to the "Chairman of the Housing Committee," and must be deposited at the Town Clerk's Office at the Town Hall, Manchester, not later than 12 o'clock noon on WEDNESDAY, the 19th JULY, 1939.

The Corporation do not bind themselves to accept the lowest or any Tender.

R. H. ADCOCK,
Town Clerk.

Housing Department,
Town Hall,
Manchester, 2.
June, 1939.

SPALDING RURAL DISTRICT COUNCIL.

TO BUILDERS AND CONTRACTORS.

The SPALDING RURAL DISTRICT COUNCIL invite TENDERS for the ERECTION of TWELVE HOUSES in MOULTON SEA'S END.

Plans, Specifications and Forms of Tender may be obtained from the Council's Architect, F. Bernard Saunders, 8, Herring-lane, Spalding, Lincs, on deposit of £2 2s., which will be refunded on receipt of a bona-fide Tender.

Sealed Tenders, endorsed "Council Houses," to be delivered to the undersigned not later than First Post on SATURDAY, 15th JULY, 1939.

The Council do not bind themselves to accept the lowest or any Tender.

E. J. S. MAPLES,
Clerk to the Council.

Spalding.
23rd June, 1939.

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GLOUCESTERSHIRE EDUCATION COMMITTEE.

SENIOR CHURCH OF ENGLAND SCHOOL—FAIRFORD.

TENDERS are invited from CONTRACTORS for the ERECTION of the above SCHOOL. Applications for Bills of Quantities and Form of Tender should be made to W. E. Ellery Anderson, L.R.I.B.A., 12, Imperial-square, Cheltenham, not later than Saturday, 8th July, 1939, accompanied by a cheque for Two Guineas, which will be returned upon receipt of a bona-fide Tender.

Tenders, in sealed envelope endorsed "Fairford Church of England Senior School," must be forwarded to reach the Architect's Office, 12, Imperial-square, Cheltenham, not later than TUESDAY, 15th AUGUST, 1939.

The successful Contractor will be required to observe the Fair Wages Clause adopted by the County Council.

The lowest or any Tender will not necessarily be accepted, and no expenses will be paid for the preparation of Estimates.

RICHARD L. MOON,
Clerk of the County Council.

SHERBORNE URBAN DISTRICT COUNCIL.

TO BUILDING CONTRACTORS.

AGED PERSONS' DWELLINGS.

The COUNCIL invite TENDERS for the ERECTION of 24 DWELLINGS at HORSECASTLES, SHERBORNE, DORSET.

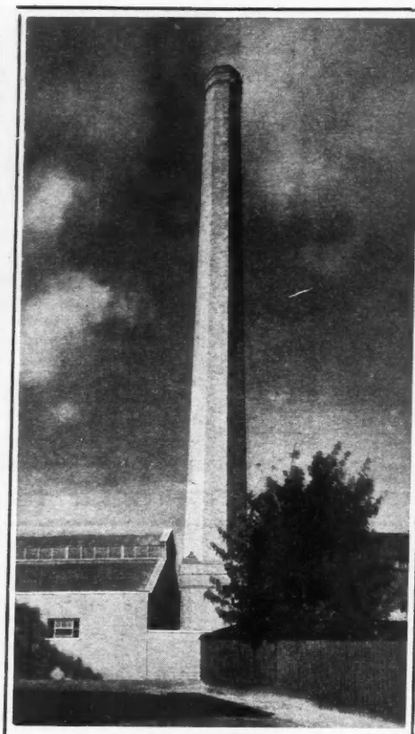
The General Conditions of Contract and Drawings may be inspected and Form of Tender and Specification may be obtained on application to Mr. T. W. Sharpe, L.R.I.B.A., Council Offices, South-street, Sherborne, on receipt of a deposit of £5, which will be refunded to bona-fide Tenderers.

Sealed Tenders, endorsed "Tender for Aged Persons' Dwellings," must be delivered to the undersigned not later than the first post on TUESDAY, the 18th day of JULY, 1939.

The Council do not bind themselves to accept the lowest or any Tender.

E. J. FREEMAN,
Clerk to the Council.

Council Offices,
South-street,
Sherborne,
Dorset.
21st June, 1939



DANKS OF NETHERTON LTD.
NETHERTON, DUDLEY.
LONDON OFFICE: 329, HIGH HOLBORN, W.C.1
FOR THIRTY-FIVE YEARS
SPECIALISTS IN BUILDING OF
CHIMNEY-SHAFTS
BOILER SETTINGS AND BOILER HOUSES

CITY OF NORWICH.

EDUCATION COMMITTEE.

NORMAN SCHOOLS REORGANISATION.

In connection with the REORGANISATION SCHEME for the above SCHOOLS, applications for names of Firms are invited for inclusion in a list to submit TENDERS for the following :—
STEELWORK.
HEATING and DOMESTIC HOT WATER.
ELECTRIC LIGHTING and POWER INSTALLATION.
WINDOWS and LANTERN LIGHTS.
IRONMONGERY.
SANITARY FITTINGS.

Applications should be addressed to the City Architect, City Hall, Norwich, and must be delivered not later than SATURDAY, the 8th JULY, 1939. Applications should be endorsed "Tenders, Norman Schools."

The Corporation does not bind itself to accept the lowest or any Tender for any of the works.

COUNTY COUNCIL OF THE WEST RIDING OF YORKSHIRE.

BINGLEY MODERN SCHOOL AND TECHNICAL INSTITUTE.

TENDERS are invited for the ELECTRICAL INSTALLATION in connection with the ERECTION of the BINGLEY MODERN SCHOOL and TECHNICAL INSTITUTE.

Plans and Specifications may be obtained on application to the Education Officer, County Hall, Wakefield, or to the Architects, Messrs. W. G. Newton & Partners, 4 Raymond-buildings, Gray's Inn, London, W.C.1.

Tenders, in sealed envelopes, endorsed "Bingley Modern School and Technical Institute—Electrical Installation," are to be sent to me, the undersigned, not later than 9 a.m. on the 17th JULY, 1939.

J. CHARLES McGRATH,
Clerk of the County Council.

County Hall, Wakefield.

Business Letterheads EMBOSSED without DIES.
An up-to-date embossing process now enables you to have your letterheads, etc., embossed without the high initial cost of a die (which requires renewing if Tel. No., Address, etc. are changed). Results are indistinguishable from die-stamping and in many cases greatly superior as regards flexibility and permanency.
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B639

PRESTWICH PROPOSED R.C. SCHOOL.

The PROPOSERS invite applications to TENDER for the ERECTION of the above ELEMENTARY SENIOR SCHOOL at HIGHFIELD-ROAD, PRESTWICH.

Plans may be seen and General Conditions of Contract and Quantities obtained on application to H. Greenhalgh, P.A.S.I., F.I.A.A., 15, Mawdsley-street, Bolton, on payment of a deposit of £2 (which will be returned on receipt of a bona-fide Tender).

Applications (with deposit) to tender must be received not later than the 7th July, 1939.

The Contractor whose Tender is accepted will be required to provide a satisfactory surety for the due performance of the Contract.

The Proposers do not bind themselves to accept the lowest or any Tender.

Tenders must be delivered not later than the first post on SATURDAY, 29th JULY, 1939, in a plain sealed envelope addressed to "The Clerk of the County Council," County Offices, Preston, and endorsed "Tender for Prestwich Proposed R.C. School," but must not bear any name or mark indicating the sender.

(Signed) H. GREENHALGH,
Architect to the Proposers.

15, Mawdsley-street,
Bolton.
29th June, 1939.

BOROUGH OF CHATHAM.

EDUCATION COMMITTEE.

TO BUILDERS AND CONTRACTORS.

The EDUCATION COMMITTEE invite TENDERS for RETILING the ROOFS of—
(a) the BOYS' SCHOOL,
(b) the GIRLS' SCHOOL,
(c) the HANDICRAFT, DOMESTIC SCIENCE and MEDICAL INSPECTION BLOCK,
at the LUTON-ROAD (COUNCIL) SCHOOLS, CHATHAM.

Bills of Quantities may be obtained and General Conditions of Contract inspected on application to Mr. R. J. Honey, F.S.I., Architect to the Committee, Town Hall, Chatham, on production of a receipt from the Borough Treasurer for a deposit of Two Guineas, which sum will be returned on receipt of a bona-fide Tender and any documents supplied.

Tenders to be delivered in accordance with the instructions printed on the form of Tender, to the undersigned not later than 10.30 a.m. on TUESDAY, 11th JULY, 1939.

The Education Committee do not bind themselves to accept the lowest or any Tender, and reserve the right of dividing the contract.

P. S. TAYLOR,
Education Officer.

Elm House,
New Road-avenue,
Chatham,
20th June, 1939.

TO BUILDERS AND CONTRACTORS.

CITY OF LEEDS.

TENDERS are invited by the HOUSING COMMITTEE for the following on BRIANSIDE (EXTENSION), SEACROFT :—

1.—CONTRACT NO. 149.
FORMATION, PITCHING, ETC., OF ROADS AND FOOTPATHS.

Specifications, Bills of Quantities and Form of Tender may be obtained and the Plans and Sections inspected at the office of the undersigned, on and after Monday, 3rd July, 1939.

2.—CONTRACT NO. 150.
ERECTION AND COMPLETION OF 14 BRICK HOUSES (TYPES A2 and A3).

Specifications, Forms of Tender and a copy of the Plans of the Houses and Cottage Flats can be obtained at the office of the undersigned, on and after Monday, 3rd July, 1939.

A deposit of £2 will be required for each Contract, which will be returned on receipt of a bona-fide Tender, and return of the Specification and Plans.

All cheques are to be made payable to the order of the "Leeds Corporation" and crossed "and Co."

Tenders, properly endorsed, must be delivered (in the special envelope supplied therefor) at the Town Clerk's Office, Room 57, Civic Hall, Leeds, 1, not later than 12 Noon on MONDAY, 17th JULY, 1939.

The Corporation does not bind itself to accept the lowest or any Tender, and no allowance will be made for Tenders.

R. A. H. LIVETT, A.R.I.B.A.,
Housing Director.

26, Great George-street,
Leeds, 1.
July, 1939.

BOROUGH OF OLDBURY.

ERECTION OF 50 HOUSES ON THE CAUSEWAY GREEN ESTATE.

The CORPORATION invite TENDERS for the ERECTION of 50 HOUSES on the CAUSEWAY GREEN ESTATE.

Specifications, Forms of Tender and Plans may be obtained on application to the Borough Surveyor, Municipal Bank Chambers, Oldbury, on payment of a deposit of Two Guineas, to be returned on receipt of bona-fide Tender and return of Plans.

Sealed Tenders, in the envelope provided, must be delivered to the undersigned not later than 12 noon on THURSDAY, 20th JULY, 1939.

ARTHUR CULWICK,
Town Clerk.

Municipal Buildings,
Oldbury.
26th June, 1939.

SURREY COUNTY COUNCIL.

HIGHWAYS AND BRIDGES DEPARTMENT.

DECONTAMINATION BUILDING, EWELL.

TENDERS are invited for the ERECTION and COMPLETION of a DECONTAMINATION BUILDING at EWELL DEPOT, EWELL.

Drawings, Specifications and Conditions of Contract may be inspected at the office of the County Engineer, County Hall, Kingston-on-Thames, and Instructions to Tenderers and Forms of Tender may be obtained on receipt of a cheque for £2 2s. This deposit will be returned on receipt of a bona-fide Tender.

Tenders, on the form provided, enclosed in a plain sealed envelope (which shall not bear any name or mark indicating the sender), addressed to the "Clerk of the County Council," County Hall, Kingston-on-Thames, and endorsed "Tender—Decontamination Building," must reach the Clerk of the Council not later than 5 p.m. on FRIDAY, the 7th of JULY, 1939.

Unless these conditions are complied with, Tenders will not be considered.

The Council do not bind themselves to accept the lowest or any Tender.

DUDLEY AUKLAND,
Clerk of the Council.

County Hall,
Kingston-upon-Thames.
26th June, 1939.

CONTRACTS OPEN

HARROW URBAN DISTRICT COUNCIL.

TO BUILDERS AND CONTRACTORS.

TENDERS are invited for the ERECTION and COMPLETION of an AUXILIARY FIRE SERVICE BUILDING rear of the Headquarters Fire Station, Pinner-road, North Harrow.

The new building comprises Trailer Pump Store, Locker and Dressing-room and Ladder Store on the Ground Floor, Recreation Room, Lecture Rooms, Kitchen, Decontamination Rooms and Lavatories on the First Floor.

Copies of the Bill of Quantities and Form of Tender may be obtained and the Drawings inspected on application to Mr. H. W. Rackham, F.S.I., Engineer and Surveyor, on payment of a deposit fee of £3 3s., which will be returned on receipt of a bona-fide Tender.

Tenders, endorsed "Auxiliary Fire Service Building," to be forwarded in plain sealed envelopes to the undersigned not later than 10 a.m., SATURDAY, the 15th JULY, 1939.

The Council do not bind themselves to accept the lowest or any Tender.

VERNON YOUNGER,
Clerk to the Council.

Council Offices,
Uxbridge-road,
Stanmore.
30th June, 1939.

SOUTHAMPTON CORPORATION WATERWORKS.

RIVER ITCHEN SUPPLY—CONTRACT NO. 6.

CONTRACT FOR THE CONSTRUCTION OF BUILDING WORK IN THE PARISH OF OTTERBOURNE, HAMPSHIRE.

The CORPORATION invite TENDERS from FIRMS experienced in Building Work and Reinforced Concrete Work for the CONSTRUCTION of BUILDINGS for the RIVER ITCHEN SUPPLY WORKS, comprising Pump Houses, Filter Houses, Engine Foundations and certain Auxiliary Works, in the PARISH of OTTERBOURNE, HAMPSHIRE.

Drawings may be inspected at the Waterworks Office, Civic Centre, Southampton, and copies of the Specification, etc., may be obtained from that Office on payment of a deposit of £5, which amount will be refunded on receipt of a bona-fide Tender.

Sealed Tenders to be delivered not later than 10 a.m. on FRIDAY, the 14th JULY, 1939, addressed to the Town Clerk, Civic Centre, Southampton, endorsed "River Itchen Supply—Contract No. 6."

The Corporation do not bind themselves to accept the lowest or any Tender.

R. RONALD H. MEGGESON,
Town Clerk.

June, 1939.

BOROUGH OF ERITH.

SCHOOL REPAIRS, ETC., 1939—SUB-CONTRACTS.

The CORPORATION invite TENDERS for the following Sub-Contract Works to existing Main Contracts:—

(1) HARDWOOD FLOORS at ST. FIDELIS, PICARDY and BEDONWELL SCHOOLS;

(2) SANITARY FITTINGS at WEST-STREET, PICARDY and BEDONWELL SCHOOLS;

(3) STEELWORK; (4) METAL WINDOWS; (5) BITUMINOUS ROOFING; and

(6) PLAYGROUND SURFACING, all at BEDONWELL SCHOOL.

Plans may be seen, and Bills of Quantities, General Conditions of Contract, Specification and Form of Tender may be obtained on application to Mr. John H. Clayton, Borough Engineer and Surveyor, Council Offices, Erith, upon payment of One Guinea in respect of each item (1), (2), etc., which will be returned after delivery of a complete and bona-fide Tender (providing such Tender is not withdrawn) and the return of all documents.

Tenders must be on the form provided, enclosed in a sealed envelope endorsed on the outside "Tender for Hardwood Floors," or as the case may be, and should be delivered to the undersigned not later than 12 noon on MONDAY, the 10th day of JULY, 1939.

The Contractor must be prepared to enter into a formal contract, and, if required, a bond with two sureties for the due performance of the Contract.

The Corporation do not bind themselves to accept the lowest or any Tender.

DOUGLAS S. TWIGG,
Town Clerk.

Town Clerk's Office,
Erith.

ROYAL BOROUGH OF KINGSTON-UPON-THAMES.

TO BUILDING CONTRACTORS.

The CORPORATION invite TENDERS for the ERECTION of a STAGE and DRESSING-ROOMS at the rear of PUBLIC BATHS within the Borough.

Bill of Quantities, together with Form of Tender, may be had on application to the Borough Surveyor on or before Saturday, the 8th July, 1939, on the payment of a deposit of Two Guineas, which deposit will be returned on receipt of a bona-fide Tender.

Tender, enclosed in a sealed envelope endorsed "Baths Stage," which shall not bear any name or mark indicating the sender, are to be delivered to me not later than noon on MONDAY, 24th JULY, 1939.

The Corporation do not bind themselves to accept the lowest or any Tender.

A. W. FORSDIKE,
Town Clerk.

Guildhall,
Kingston-upon-Thames.
June, 1939.

BOROUGH OF CHATHAM EDUCATION COMMITTEE.

SCHOOL FURNITURE.

TENDERS are invited for the SUPPLY of DESKS, TABLES, etc., which will be required for the HIGHFIELD SENIOR BOYS' SCHOOL now in course of erection.

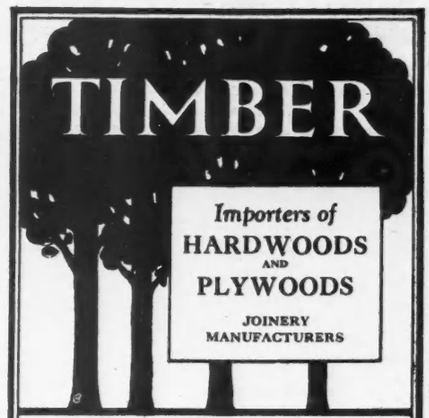
Forms of Tender and Specification may be obtained from the Education Officer, Elm House, 15, New Road-avenue, Chatham.

Sealed Tenders, enclosed in a plain envelope endorsed "Tender for School Furniture," must be forwarded to the undersigned not later than the 17th JULY, 1939.

The Committee do not bind themselves to accept the lowest or any Tender.

EDWARD B. LEE,
Town Clerk.

Town Hall,
Chatham.



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BOROUGH OF WALTHAMSTOW.

ELECTRICITY UNDERTAKING.
HALE END-ROAD ELECTRICITY SUB-STATION.
TO GENERAL AND REINFORCED CONCRETE CONTRACTORS.

The CORPORATION invite TENDERS for the ERECTION of a SINGLE-STOREY ELECTRICITY SUB-STATION, with attendant Works, at the above Site.

Contractors desirous of tendering are requested to make written application for a Form of Tender, Conditions of Tender and Contract, with copy of Drawings and Specification, to Mr. Frank H. Heaven, A.R.I.B.A., F.A.S.I., Architect to the Education Committee, at Old Monoux Building, High-street, Walthamstow, E.17, accompanied by a cheque or deposit of £2 (payable to the Borough Treasurer), which will be returned on receipt of a bona-fide Tender.

Certain conditions regarding rates of wages, hours and percentages of labour will be required to be observed.

Tendors, on the form provided, endorsed "Tenders for Sub-Station," must be delivered in plain sealed envelopes, without any name or mark indicating the sender, by post only, to the undersigned not later than 12 noon on WEDNESDAY, the 12th day of JULY, 1939.

The Corporation do not bind themselves to accept the lowest or any Tender

FRANCIS G. GARNER,
Town Clerk.

Town Hall,
Orford-road,
Walthamstow, E.17.
22nd June, 1939

TO BUILDERS.

THE COMMISSIONERS OF HIS MAJESTY'S WORKS, etc., are prepared to receive TENDERS before 11 a.m. on:—

(1) MONDAY, 17th JULY, 1939, for the ERECTION of SHIREBROOK TELEPHONE EXCHANGE. (Drawings, etc., on view at Mansfield Head Post Office.)

(2) TUESDAY, 18th JULY, 1939, for the ERECTION of HEDNESFORD TELEPHONE EXCHANGE. (Drawings, etc., on view at Rugeley Head Post Office.)

(3) WEDNESDAY, 19th JULY, 1939, for the ERECTION of CHAPEL BRAMPTON TELEPHONE EXCHANGE (NORTHANTS). (Drawings, etc., on view at Northampton Head Post Office.)

(4) FRIDAY, 21st JULY, 1939, for the ERECTION of HEXHAM POST OFFICE. (Drawings, etc., on view at Hexham Head Post Office.)

(5) WEDNESDAY, 19th JULY, 1939, for the ERECTION of THORNTON ABBEY TELEPHONE REPEATER STATION. (Drawings, etc., on view at Grimsby Head Post Office.)

(6) FRIDAY, 21st JULY, 1939, for the ERECTION of COSHAM TELEPHONE EXCHANGE (HANTS). (Drawings, etc., on view at Cosham Head Post Office.)

Bills of Quantities and Forms for Tender may be obtained from Room 71, Ground Floor, H.M. Office of Works, London, S.W.1, on payment of One Pound in each case. (Cheques payable to the Commissioners of H.M. Works, etc.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions.

COUNTY BOROUGH OF DEWSBURY.

TEMPLE-ROAD SENIOR GIRLS' SCHOOL.

TENDERS are invited for the SUPPLY of SCHOOL FURNITURE (LABORATORY FURNISHINGS, CUPBOARDS, ART DESKS and FURNITURE, LIBRARY TABLES, CHAIRS, TABLES, STOOLS, etc.).

Specifications and Forms of Tender may be obtained from the Borough Architect and Buildings Surveyor, Town Hall, Dewsbury.

Tenders, in plain sealed envelopes endorsed "Tender—Temple-road School," to be delivered to me by 10 a.m. on THURSDAY, 13th JULY, 1939.

HOLLAND BOOTH,
Town Clerk.

Town Hall,
Dewsbury,
26th June, 1939.

BOROUGH OF HENDON.

ISOLATION HOSPITAL, GOLDSMITH-AVENUE, HENDON, N.W.9: SURGICAL UNIT.

TENDERS are invited for the ERECTION of a SURGICAL UNIT at the CORPORATION'S ISOLATION HOSPITAL.

Bills of Quantities will be issued and application for same must be made to Mr. A. O. Knight, Borough Engineer and Surveyor, Town Hall, Hendon, N.W.4, by the 7th July, 1939, accompanied by a deposit of Three Guineas (£3 3s.), which will be returned on receipt of a bona-fide Tender on the form provided. In the case of the accepted Tender the deposit will be returned on the execution, when required, of the Contract and Bond. Failing such execution the deposit will be forfeited.

The Bills will be forwarded by the Quantity Surveyors on the 10th July, 1939.

Tenders to be forwarded in the envelope provided not later than 12 noon on TUESDAY, the 25th JULY, 1939, and the envelope shall not bear any name or mark indicating the sender. Tenders received after that date and time will not receive consideration.

Bills of Quantities, fully priced out, must be delivered at the same time to Messrs. L. A. Francis & Son, Quantity Surveyors, Vernon House, Sicilian-avenue, London, W.C.1.

The Corporation does not bind itself to accept the lowest or any Tender.

Dated this 24th day of June, 1939.

LEONARD WORDEN,
Town Clerk.

Town Hall,
Hendon, N.W.4.
23rd June, 1939.

COUNTY BOROUGH OF SOUTHPORT.

EXTENSIONS TO BIRKDALE CENTRAL SCHOOL.

TO BUILDERS AND OTHERS.

The TOWN COUNCIL are prepared to receive TENDERS for the ERECTION of EXTENSIONS to the BIRKDALE CENTRAL SCHOOL, situate at WINDY HARBOUR-ROAD, BIRKDALE, SOUTHPORT.

Persons desiring to tender may inspect the Plans and Drawings either at the offices of the Architect, Leonard Barnish, Esq., F.R.I.B.A., Chartered Architect, 58, Rodney-street, Liverpool, 1, or at the Education Offices, Eastbank-street, Southport, on and after the 27th June, 1939, on any weekday between the hours of 10 a.m. and 5 p.m., and on Saturdays between the hours of 10 a.m. and 12 noon.

Application for the General Conditions, Bills of Quantities and Form of Contract and a Form of Tender should be made to the undersigned before the 30th June, 1939; with a deposit of Five Guineas, which will be returned in case a bona-fide Tender is duly made. These documents will be forwarded to Contractors as soon as possible, but the Bills of Quantities will not be ready until the 4th July, 1939.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders, which must be made on the prescribed form, are to be delivered at the latest by the first post on TUESDAY, the 18th JULY, 1939, addressed to the undersigned, and must be endorsed "Tender for Extensions at Birkdale Central School."

R. EDGAR PERRINS,
Town Clerk.

Town Hall,
Southport.
22nd June, 1939.

ORPINGTON URBAN DISTRICT COUNCIL.

EXTENSION OF COUNCIL OFFICES.

The above-named COUNCIL invite TENDERS for the ERECTION and COMPLETION of EXTENSIONS to the COUNCIL OFFICES, ORPINGTON.

The Drawings, Form of Agreement, etc., may be seen at the offices of the Architects, Messrs. Robert Atkinson, FF.R.I.B.A., 13, Manchester-square, W.1, or at the Council's Offices, between the hours of 10 a.m. and 4 p.m., Saturdays from 10 a.m. to 12 noon, from 4th to 15th July, 1939.

Applications for Form of Tender and Bills of Quantities must be received by the Architects not later than noon on Monday next, 3rd July, and must be accompanied by a deposit of £3 3s., which will be returned on receipt of a bona-fide Tender which is not subsequently withdrawn, and the return of all documents.

Sealed Tenders, in plain envelopes endorsed "Extension of Council Offices," must be received by the undersigned not later than noon on MONDAY, the 17th JULY, 1939.

The Council do not bind themselves to accept the lowest or any Tender.

LEONARD O. WALL,
Clerk of the Council.

Council Offices,
Orpington, Kent.
26th June, 1939.

FINSBURY BOROUGH COUNCIL.

TENDERS are invited for the EXECUTION of ALTERATIONS at the OLD-STREET UNDERGROUND CONVENIENCE.

Particulars and Forms of Tender may be obtained either personally from or by sending a stamped addressed foolscap envelope to the Borough Engineer, Finsbury Town Hall Annexe, Rosebery-avenue, E.C.1.

Intending Contractors, before tendering, must sign a declaration and undertaking as to observance of Trade Union rates of wages, hours of labour and conditions of employment, copies of which may be obtained from the Borough Engineer. Only those firms who sign and return such undertaking will be supplied with the necessary Form of Tender and Specification. All Tenders will be subject to the General Conditions of Contract, a copy of which will be annexed to the Form of Tender.

Completed Tenders, in the official envelope provided, must be received by the undersigned not later than first post on SATURDAY, 8th JULY, 1939.

J. E. ARNOLD JAMES,
Town Clerk.

Finsbury Town Hall,
Rosebery-avenue, E.C.1.

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CONTRACTS—*continued*

COUNTY BOROUGH OF NEWPORT.

CIVIC CENTRE SCHEME.

The CORPORATION of NEWPORT will proceed with the FOURTH SECTION of the above SCHEME, comprising the ERECTION of the ASSEMBLY HALL BLOCK to the design of Mr. T. Cecil Howitt, F.R.I.B.A.

The building measures 90 × 212 feet on plan and has a content of approximately 880,000 cubic feet.

The buildings will be mainly two storeys high, of fire-resisting construction with a minimum of steelwork and faced externally in Portland stone.

The Corporation invite Tenders for the erection of the building referred to from firms or persons who have carried out works of a similar character and magnitude, and Tenderers will be required to submit with their Tender a list of similar works executed by them.

Applications for Bill of Quantities, Specification, Conditions and Form of Contract, accompanied by the Borough Treasurer's receipt for £5 deposit (which will be returned on receipt of a bona-fide Tender), must reach the undersigned not later than the 10th day of JULY, 1939.

Tenders and accompanying documents must be sent only in the special envelope which will be provided and must reach the undersigned not later than 10 a.m. on TUESDAY, the 1st day of AUGUST, 1939.

No Tender will be considered if sent in an envelope which bears any name or mark indicating the sender or if received after the time stated.

Dated this 26th day of June, 1939.

O. TREHARNE MORGAN,
Town Clerk.

Town Hall,
Newport, Mon.

COUNTY BOROUGH OF DERBY.

ERECTION OF 139 HOUSES, RADFORD-STREET.
ERECTION OF 163 HOUSES, ROE FARM.

The CORPORATION of DERBY invite TENDERS from competent BUILDERS and CONTRACTORS for the
ERECTION of 139 HOUSES, RADFORD-STREET;
ERECTION of 163 HOUSES, ROE FARM.

Forms of Tender, Specifications and Drawings may be obtained at the Office of the undersigned on and after Wednesday, 5th July, 1939, upon the deposit of £1 1s. for each Contract, which will be returned on receipt of a bona-fide Tender, or upon the return of the Drawings, etc., at once if no Tender is to be submitted.

The attention of the Contractor is specially drawn to the Clause in the General Conditions relating to the Standard Rate of Wages, and Sub-letting Contracts, and he will be required to state if he is on the King's Roll.

Sealed Tenders are to be sent in the Official Envelope provided and are to be delivered at the Town Clerk's Office, Market Place, Derby, not later than 9 a.m. on WEDNESDAY, 26th JULY, 1939, endorsed "Tender for ..... Houses,"

The lowest or any Tender will not necessarily be accepted.

Cheques should be made payable to "Derby Corporation."

C. H. ASLIN, F.R.I.B.A., M.I.Struct.E.,
Borough Architect.

Gower-street,
Derby.

RURAL DISTRICT COUNCIL OF NORTON.

HOUSING ACTS, 1936-38.

ERECTION OF 116 HOUSES.

The RURAL DISTRICT COUNCIL of NORTON invite TENDERS for the ERECTION and COMPLETION of FORTY-TWO A2 TYPE, FIFTY-EIGHT A3 TYPE and SIXTEEN A4 TYPE HOUSES in the following Townships, viz. :—

Township.	Number and Type of Houses. A2	A3	A4
Contract "A."—Butterwick	—	2	—
Foxholes	6	6	2
Contract "B."—Luttons	4	8	2
Weaverthorpe	8	20	2
Contract "C."—Kennythorpe	—	6	2
Rillington...	24	16	8
Totals	42	58	16

Plans may be inspected by appointment at the Office of the Council's Architect (S. Cook, Esq., F.I.A.A., Rural District Council Offices, Malton), and copies of Specifications, Conditions of Contract and Forms of Tender may be obtained from the undersigned on or after 5th July, 1939, upon payment of £2 2s. (by cheque only) to the order of the Norton Rural District Council. The deposit will be returnable only if the Tenderer shall have sent in a bona-fide Tender and shall not have withdrawn the same.

Contractors may submit Tenders for the whole or any portions of the work above referred to, and when applying for Specifications and Forms of Tender they should indicate which portion of the Contract they intend to tender for.

The Contracts entered into will substantially follow the model series issued by the Ministry of Health and will contain a Fair Wages Clause. Tenders must be "firm tenders" not subject to adjustment for variations in the cost of wages or materials, and it will be a condition of all Contracts entered into that the materials shall, as far as practicable, be of British or Empire origin.

Sealed Tenders, addressed to the undersigned and endorsed "Tender—Housing Contracts (A), (B) or (C)," as the case may be, must be delivered by noon on WEDNESDAY, the 26th JULY, 1939.

The Council do not bind themselves to accept the lowest or any Tender.

T. W. PRESTON,
Clerk of the Council.

Rural District Council Offices,
Malton.
27th June, 1939.

MERTON AND MORDEN URBAN DISTRICT COUNCIL.

CONSTRUCTION OF CHAPEL AND OTHER CEMETERY BUILDINGS.

The COUNCIL invite TENDERS for the CONSTRUCTION and COMPLETION on the Site of the NEW CEMETERY at GARTH-ROAD, LOWER MORDEN, of CHAPEL, LODGE, WAITING-ROOM and LAVATORIES, MORTUARY, MESSROOM and GREENHOUSES. Instructions for Tender, Tender Form, Conditions of Contract and Bills of Quantities will be supplied, and the Drawings may be inspected during office hours, on application at the office of the Architect, Mr. Albert J. Thomas, F.R.I.B.A., 31a and 32, Sloane-street, S.W.1, upon deposit of the sum of Three Guineas with the Council's Treasurer at the Council Offices, Kingston-road, Merton, S.W.19, which will be returned on receipt of a bona-fide Tender which is not subsequently withdrawn.

Tenders, on the prescribed Forms, must be delivered to the Clerk to the Merton and Morden Urban District Council, Dorset Hall, Kingston-road, Merton, S.W.19, not later than 10 o'clock on WEDNESDAY, the 19th day of JULY, 1939.

Late Tenders will not be considered. Canvassing will disqualify.

The Council do not bind themselves to accept the lowest or any Tender.

The successful Tenderer will be required to provide a Bond from an approved Insurance or Guarantee Company in the sum of £1,000, for the due performance of the Contract, and will be required to observe the Conditions of Labour and pay the wages recognised by associations of employers and trade unions in the district.

C. J. MOUNTIFIELD,
Clerk to the Council.

Dorset Hall,
Kingston-road,
Merton, S.W.19.
27th June, 1939.

BOROUGH OF OLDBURY.

EDUCATION COMMITTEE.

UNDERGROUND SHELTERS FOR PROTECTION OF SCHOOL CHILDREN.

TENDERS are invited for the necessary EXCAVATION, SUPPLY and FIXING of REINFORCED CONCRETE UNITS, DRAINAGE, etc., for the CONSTRUCTION of 104 UNDERGROUND AIR RAID SHELTERS in the PLAYGROUNDS and RECREATION FIELDS for the protection of Scholars attending the Schools in the Borough.

Copy of Drawing may be inspected and Specification, Quantities and Form of Tender may be obtained from Mr. W. Greenwood, Borough Engineer and Surveyor, Municipal Bank Chambers, Oldbury, on payment of a deposit of Two Guineas, which will be returned on receipt of a bona-fide Tender.

Contractors may submit Tenders for Alternative Methods of Trench Linings which have been approved by the Home Office Air Raid Precautions Department.

Tenders, in plain sealed envelope, endorsed "School Shelters," must be delivered to J. H. Slatcher, Esq., Education Offices, Municipal Bank Chambers, Church-square, Oldbury, by 12 noon on MONDAY, 17th JULY, 1939.

The lowest or any Tender will not necessarily be accepted, and the Education Committee reserve the right to accept the whole or any portion or portions of any Tender which may be submitted.

ARTHUR CULWICK,
Town Clerk.

Municipal Buildings,
Oldbury.
27th June, 1939.

TO HEATING ENGINEERS.

WOLVERHAMPTON EDUCATION COMMITTEE.

CONSULTING HEATING ENGINEERS are invited to submit terms upon which they would be prepared to INSPECT the HEATING INSTALLATIONS at one (or two) Schools, report upon their condition, and submit schemes for improvement where necessary, with estimate of cost.

Further information (for which application should be made by not later than 5th JULY) will be given by the Director of Education, Education Offices, North-street, Wolverhampton.

COUNTY OF CHESTER.

SALE CECIL-AVENUE COUNCIL SENIOR SCHOOL.

TO CONTRACTORS AND SPECIALIST FIRMS.

TENDERS are Required in connection with the following works at the above :—

(a) PRECAST REINFORCED CONCRETE FLOORS;
(b) STEEL ROOF TRUSSES;
(c) SANITARY FITTINGS;
(d) LOW-PRESSURE HEATING INSTALLATION and DOMESTIC HOT-WATER SERVICE;
(e) ELECTRIC LIGHTING INSTALLATION;
(f) PATENT GLAZING to VERANDAHS.

Applications to tender for any of the above-mentioned items must be made to the undersigned not later than TUESDAY, the 11th JULY, 1939.

F. ANSTEAD BROWNE, F.R.I.B.A.,
County Architect.

The Castle,
Chester.
27th June, 1939.

COUNTY BOROUGH OF BOOTLE.

A.—BREEZE HILL IMPROVEMENT.
B.—LINACRE-LANE IMPROVEMENT.

SUPPLY AND ERECTION OF STONE COPING AND WROUGHT-IRON RAILINGS.

The HIGHWAYS, SANITARY AND CARTAGE COMMITTEE of the BOOTLE CORPORATION invite TENDERS for the following :—

Contract No. 1.—The Supply and Erection of approximately 290 lineal yards of 4 ft. 6 in. high Wrought Iron Ornamental Railings.

Contract No. 2.—The Supply and Fixing of approximately 874 lineal feet of 13½ in. × 6½ in. York Stone Coping, together with Caps, Steps, etc.

Copies of the General Conditions, Specifications, Bills of Quantities, Drawings and Forms of Tender may be obtained on application to Mr. W. A. Harrison, M.Eng. (L'pool), M.Inst.C.E., M.Inst.M. & Cy.E., Borough Engineer and Surveyor, Town Hall, Bootle, Liverpool, 20, on payment of a deposit of One Pound in respect of each Contract, which amount will be refunded on receipt of a bona-fide Tender not subsequently withdrawn.

The Corporation do not bind themselves to accept the lowest or any Tender.

No Tender will be considered except in the plain envelope provided, sealed and endorsed as applicable and addressed to the Town Clerk, Town Hall, Bootle, so as to reach him not later than 10 a.m. on TUESDAY, the 11th JULY, 1939.

The envelope must not bear any name or mark indicating the sender.

By Order,
HAROLD PARTINGTON,
Town Clerk.

Town Hall,
Bootle.
28th June, 1939

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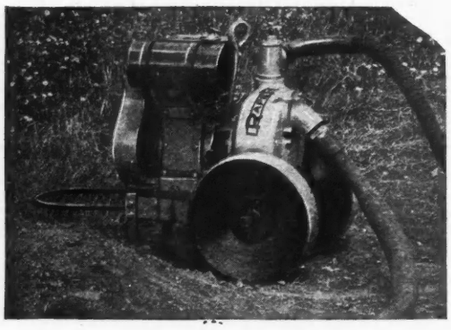

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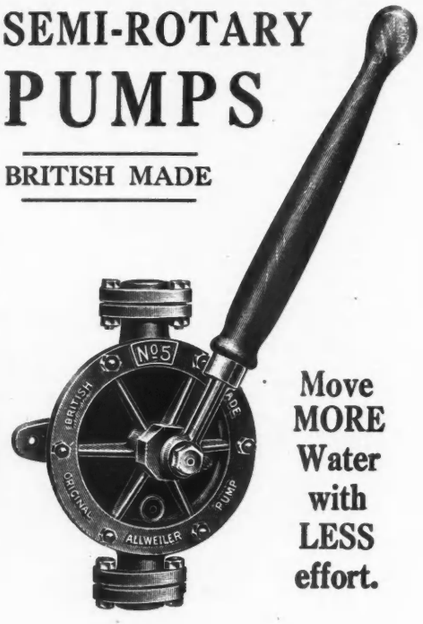

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For particulars of membership and examinations, apply to the Secretary. The Association has opened a Registration Bureau where advice may be obtained, free, by architects and architectural assistants wishing to be registered under the Architects (Registration) Acts.

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PUBLIC APPOINTMENTS.

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AIR MINISTRY.

The AIR MINISTRY requires the services of competent ASSISTANT QUANTITY SURVEYORS. Salaries £500 a year. Applicants must have been trained as Building Quantity Surveyors and have had considerable experience in measurement of work and adjustment of variations in large building contracts. Preference will be given to applicants holding the P.A.S.I.

The appointments are at Aerodromes in the Provinces.

Age limits 23-55.

Requests for forms of application should be addressed to the UNDER-SECRETARY OF STATE, AIR MINISTRY (W.9), Adastral House, Kingsway, London, W.C.2, *enclosing an addressed unstamped envelope.*

AIR MINISTRY.

Applications are invited for appointments as ASSISTANTS in the Drawing Office, as follows:—

(a) REINFORCED CONCRETE DESIGNERS. Experience in all classes of concrete work. Age limits: over 25 but not exceeding 55. Salary up to £420 per annum, according to qualifications.

(b) REINFORCED CONCRETE DETAILERS. Experience in all classes of concrete work. Age limits: over 21 but not exceeding 55. Salary up to £320 per annum, according to qualifications.

In addition, a limited number of vacancies exist for JUNIORS with experience in the foregoing. Salaries for these appointments will be up to £3 10s. per week.

Appointments, subject to satisfactory service, are expected to last for two or three years, but no guarantee can be given.

Requests for forms of application should be addressed to the UNDER-SECRETARY OF STATE, AIR MINISTRY (W.9), Adastral House, Kingsway, London, W.C.2, *enclosing an addressed unstamped envelope.*

AIR MINISTRY.

Applications are invited for appointments as ASSISTANTS in the DRAWING OFFICE. Candidates must have had experience in one of the following:—

(a) Design and detailing of water supply schemes; or

(b) Design and detailing of sewerage and sewage disposal schemes; or

(c) Design of structural steelwork.

Salaries offered are from £210 to £320, or from £320 to £420, assessed on qualifications and experience, and are on an incremental basis up to the maxima mentioned, subject to satisfactory service. Age limits 21-55.

In addition, a limited number of vacancies exist for JUNIORS with experience in the foregoing. Salaries for these appointments will be up to £3 10s. per week.

Appointments, subject to satisfactory service, are expected to last for two or three years, but no guarantee can be given.

Requests for forms of application should be addressed to the UNDER-SECRETARY OF STATE, AIR MINISTRY (W.9), Adastral House, Kingsway, London, W.C.2, *enclosing an addressed unstamped envelope.*

ADMIRALTY—CIVIL ENGINEER-IN-CHIEF'S DEPARTMENT.

REQUIRED for a period of probably two years, the SERVICES of SEVERAL competent ASSISTANT QUANTITY SURVEYORS. Salaries up to £500 a year, according to qualifications and experience. Applicants must have been trained as Quantity Surveyors and have had considerable experience in:—

(a) Estimates for building and engineering works and the preparation of quantities and contract particulars;

(b) Measurement of work and adjustment of variations in large building or engineering contracts.

The appointments, which are temporary, are for the Admiralty, London, and Naval Establishments at Home.

Applicants who have previously applied for similar posts and who desire to be again considered must submit fresh applications.

Age limits 24-45.

Applications, stating age, giving full particulars of qualifications, experience, and enclosing COPIES of testimonials, to be addressed to the CIVIL ENGINEER-IN-CHIEF, Admiralty, S.W.1.

Envelopes and applications to be marked in top left-hand corner "Assistant Surveyors."

WAR DEPARTMENT.

Required, in the Office of the C.R.E., London district, the services of TWO TEMPORARY ASSISTANT QUANTITY SURVEYORS.

Salary £350 to £450 per annum, according to qualifications.

Candidates must have been trained as Quantity Surveyors, and have had good experience in—

(a) Taking off,

(b) Measurement of work and adjustment of variations in building contracts.

Applications, stating age, giving full particulars of qualifications, experience, and enclosing copies of testimonials, to be addressed to C.R.E., London District, Horse Guards, Whitehall, S.W.1.

WAR DEPARTMENT.

WESTERN COMMAND.

TO ARCHITECTS AND QUANTITY SURVEYORS.

Required, for periods of nine months to two years, the services of competent QUANTITY SURVEYORS for duty at CHESTER and SHREWSBURY. Salary according to qualifications and experience.

Applicants must have been trained as Building Quantity Surveyors, and must have had considerable experience in measurement of work, in the adjustment of variations in building contracts, and in the preparation of quantities for buildings, roads, drainage, and water services.

The appointments are non-pensionable.

Applicants should state the place for which they offer their services.

Applications, stating age, and giving full particulars of qualifications, experience, and salary required, and enclosing copies of testimonials, to be addressed to—

THE CHIEF ENGINEER,
Western Command Headquarters,
Queen's Park,
Chester.

THE WAR DEPARTMENT Require the services of a competent TEMPORARY CIVILIAN QUANTITY SURVEYOR at COLCHESTER, Essex.

Applicants must have been trained as Building Quantity Surveyors, and have had considerable experience in the measurements of work and adjustment of variations in large building contracts.

Preference will be given to applicants holding the P.A.S.I.

Normal salary is from £350 to £450 per annum.

Applications, stating age and experience, with copies of recent testimonials, should be made to the C.R.E., Colchester and 4th Division, Flagstaff-road, Colchester, Essex.

THE WAR OFFICE.

DIRECTORATE OF FORTIFICATIONS AND WORKS.

A QUANTITY SURVEYOR is Required for a temporary vacancy in the War Office. Candidates should have had not less than five years' experience in a Quantity Surveyor's Office. Must be of British birth and parentage and under the age of 60 years. Salary will be fixed within a maximum of £450 per annum, according to the qualifications of the candidates.

The duration of the appointment will be for at least 12 months.

Application should be made not later than MONDAY, 10th JULY, on the form to be obtained from the UNDER-SECRETARY OF STATE FOR WAR (C.4, Room 108), Whitehall, S.W.1.

WAR DEPARTMENT.

TWO TEMPORARY ARCHITECTURAL and CIVIL ENGINEERING ASSISTANTS required for 9-12 months approx. (must be good draughtsmen and levellers), for new construction work at Dover and Canterbury.

Salary £210 by £12 to £320 per annum.

Applications, giving age and experience, accompanied by copies of testimonials, to be addressed to D.C.R.E., R.E. Headquarters, Archcliffe, Dover.

BOROUGH OF BARKING.

BOROUGH ARCHITECT'S DEPARTMENT.

Applications are invited for the appointment of a TEMPORARY ARCHITECTURAL ASSISTANT, the duration of the appointment probably being for two years.

The commencing salary will be £300 per annum, rising by an increment of £15 at the end of the first year to £315, subject to satisfactory service.

Preference will be given to candidates who are members of the Royal Institute of British Architects, and forms of application may be obtained from Mr. C. C. Shaw, B.Arch. (L'pool), A.R.I.B.A., the Borough Architect, Town Hall, Barking, Essex, and must be received by the undersigned by 5 p.m. on FRIDAY, 7th JULY, 1939.

Canvassing will disqualify.

S. A. JEWERS,
Town Clerk.

Town Hall,
Barking, Essex.
20th June, 1939.

COUNTY BOROUGH OF ROCHDALE.

TEMPORARY ARCHITECTURAL ASSISTANT.

Applications are invited for the appointment of a TEMPORARY ARCHITECTURAL ASSISTANT for work in connection with Air Raid Precautions, at a salary of £400 per annum.

Applications to be made on form to be obtained from the Borough Surveyor, Town Hall, Rochdale, to whom they must be returned not later than 9 a.m. on TUESDAY, the 11th JULY, 1939.

HARRY BANN,
Town Clerk.

Town Hall, Rochdale.
24th June, 1939.

COUNTY BOROUGH OF SWANSEA.

THIRD ASSISTANT QUANTITY SURVEYOR.

Applications are invited for the position of THIRD ASSISTANT QUANTITY SURVEYOR in the Borough Architect's Department. Salary £251 per annum (paid monthly), rising, subject to satisfactory service, by annual increments of £12 10s. to a maximum of £308 per annum.

The appointment is subject to the provision of the Local Government Superannuation Act, 1937, and the successful candidate will be required to pass a medical examination.

Candidates must be under 45 years of age.

The appointment may be terminated by one month's notice on either side.

Candidates must have been trained as Quantity Surveyors and must be well experienced in preparing quantities (Standard Method of Measurement) and specifications for large building works, estimating and adjustment of contract amounts. Municipal or County Council experience desirable.

Applications, stating age, training, qualifications and details of experience, together with copies of three recent testimonials, to be delivered to the undersigned not later than WEDNESDAY, 12th JULY, 1939.

Canvassing will disqualify

(Signed) H. T. LANG-COATH,
Town Clerk.

Guildhall, Swansea.
26th June, 1939.

CITY OF LEICESTER.

CITY ENGINEER AND SURVEYOR'S DEPARTMENT.

Applications are invited for the appointment of a JUNIOR ARCHITECTURAL ASSISTANT at a commencing salary of £200 per annum, rising by annual increments of £12 10s. to £250 per annum, Grade "C."

The position is subject to the provisions of the Local Government Superannuation Act, 1937, and the successful applicant will be required to pass a medical examination.

Applications are to be made on the prescribed forms, which may be obtained from me, and be delivered at my office not later than TUESDAY, 11th JULY, 1939, endorsed "Junior Architectural Assistant."

Canvassing will be a disqualification.

A. T. GOOSEMAN, M.Inst.C.E.,
City Engineer and Surveyor.

Town Hall,
Leicester,
26th June, 1939.

BOROUGH OF CHELTENHAM.

ASSISTANT BUILDING INSPECTOR.

Applications are invited for the post of ASSISTANT BUILDING INSPECTOR at a commencing salary of £200 per annum, rising, subject to satisfactory service, by annual increments of £12 10s. to a maximum of £250.

Applicants not exceeding 30 years of age must be thoroughly conversant with, and have served as skilled tradesmen in, the building industry or have received other approved training. Experience of building inspection under a local authority would be an advantage.

The successful candidate will require to pass a medical examination and to contribute to the scheme under the Local Government Superannuation Act, 1937.

Applications, in candidates' own handwriting, stating age, qualifications and experience, and accompanied by copies of two recent testimonials, to be sent at once to the undersigned.

Canvassing in any form will be deemed a disqualification.

G. GOULD MARSLAND, B.Sc., M.Inst.C.E.,
Borough and Water Engineer.

Municipal Offices,
Cheltenham.
26th June, 1939.

LONDON COUNTY COUNCIL.

CHIEF INSTRUCTOR Required in a temporary capacity in Architect's Department, to supervise and co-ordinate the training in Five Schools of parties for A.R.P. rescue, shoring and demolition work. Knowledge of structural engineering, mechanics of building, unexploded bombs and oxy-acetylene cutting required. Remuneration according to qualifications and experience, but not exceeding 10 Guineas a week.

Apply to ARCHITECT, County Hall, Westminster Bridge, S.E.1 (stamped addressed foolscap envelope necessary), for form. Canvassing disqualifies.

COUNTY OF THE CITY OF WORCESTER.

CITY ENGINEER'S DEPARTMENT.

Applications are invited for the appointment of GENERAL CLERK OF WORKS in the CITY ENGINEER'S DEPARTMENT.

The selected candidate will be required to pass a medical examination and serve a probationary period of two years in the first instance, after which there will be a possibility (subject to satisfactory service) of the appointment being made permanent.

The salary is £3 10s. per week, rising by two annual increments of £13 to £4 per week.

Candidates should not be more than 35 years of age, and should have had a sound training in all the building trades, including setting out and supervision during construction and making reports of progress.

Applications, stating age, detailed experience and qualifications, accompanied by copies of not more than two recent testimonials, and endorsed "General Clerk of Works," must be received by me not later than 10 a.m. on WEDNESDAY, 12th JULY, 1939.

C. H. DIGBY-SEYMOUR,
Town Clerk.

Guildhall,
Worcester,
23rd June, 1939.

METROPOLITAN BOROUGH OF STEPNEY.

BOROUGH ENGINEER AND SURVEYOR'S DEPARTMENT.

AIR RAID PRECAUTIONS.

Applications are invited for the undermentioned temporary positions in the Borough Engineer and Surveyor's Department:—

FOUR ENGINEERING ASSISTANTS, maximum salary at the rate of £400 per annum.

FOUR TECHNICAL ASSISTANTS, maximum salary at the rate of £350 per annum.

Applicants must be able to make surveys, measure up and prepare drawings of buildings, and calculate for and prepare drawings and estimates for the necessary strengthening thereof.

Applications, stating age, qualifications and experience, to be sent, with copies of testimonials, to the Borough Engineer and Surveyor, Municipal Offices, Raine-street, E.1.

Canvassing, directly or indirectly, will disqualify.

WM. McCARTY,
Town Clerk.

23rd June, 1939.

CITY OF LEEDS.

CHIEF ARCHITECTURAL ASSISTANT.

Applications are invited for the following appointment:—

CHIEF ARCHITECTURAL ASSISTANT. Under the present salary scale of the Council the commencing salary for the post is £550 per annum, and the maximum salary £600 per annum.

Applicants must be Registered Architects and experienced in the supervision of a large drawing office.

The post is subject to the provisions of the Local Government Superannuation Act, 1937, and the successful applicant will be required to pass a medical examination.

Applications, on forms obtainable from the undersigned, accompanied by copies of not more than three recent testimonials (not returnable) must be delivered in the envelope supplied therefor not later than 10 a.m. on SATURDAY, the 15th JULY, 1939.

Canvassing in any form, either directly or indirectly, will be a disqualification.

R. A. H. LIVETT, A.R.I.B.A.,
Housing Director.

26, Great George-street,
Leeds, 1,
June, 1939.

MIDDLESBROUGH EDUCATION COMMITTEE.

APPOINTMENT OF TEMPORARY ASSISTANT CLERK OF WORKS.

Applications are invited for an appointment as Temporary ASSISTANT CLERK OF WORKS to assist in the supervision of the erection of two new Senior Schools and Alterations and Additions to existing School Premises.

Salary £5 5s. per week. The appointment to be subject to one month's notice on either side. Applicants must have had a good general experience in all branches of the building trade and should preferably have had actual experience as Clerk of Works on building works. They must be fully competent to set out the works, give levels, keep records, make reports and measure up as the work proceeds.

Applications, endorsed "Clerk of Works," stating age, qualifications, when at liberty, together with full particulars of previous experience, and accompanied by copies of three recent testimonials, should reach the undersigned not later than MONDAY, 17th JULY, 1939.

STANLEY MOFFETT,
Director of Education.

Education Offices,
Middlesbrough,
27th June, 1939.

NORTH RIDING OF YORKSHIRE COUNTY COUNCIL EDUCATION COMMITTEE.

ERECTION OF (1) NEW SENIOR COUNCIL SCHOOL AT YARM-ON-TEES; (2) NEW SENIOR AND JUNIOR AND INFANTS' SCHOOLS, WHITBY.

APPOINTMENT OF CLERKS OF WORKS.

Applications are invited for the posts of CLERK OF WORKS for the above Schools. In each case the salary offered is £6 10s. per week.

Candidates must be thoroughly capable and trustworthy and must have a sound practical knowledge of building works.

The persons appointed will be required to reside within three miles of the schools and to be on the works during the same hours as the workmen.

A form of application will be forwarded on the receipt of a stamped addressed envelope.

Completed applications, accompanied by copies of not more than three recent testimonials, must be returned to the undersigned so as to arrive not later than the 10th JULY, 1939.

Canvassing, directly or indirectly, will disqualify.

F. BARRACLOUGH,
Secretary.

Education Offices,
County Hall,
Northallerton.

DURHAM COUNTY COUNCIL.

CITY ENGINEER SURVEYOR AND ARCHITECT'S DEPARTMENT.

APPOINTMENT OF CLERK OF WORKS.

Applications are invited for the appointment of CLERK OF WORKS to supervise the erection of a large new General Hospital at Dryburn, Durham City.

The appointment, subject to satisfactory service, will be for the duration of the Contract. The salary will be at the rate of £350 per annum.

Applicants should not be more than 50 years of age and have had experience in the supervision of large Building Contracts. Preference will be given to those with experience of Hospital Construction.

Forms of application can be obtained from the undersigned and must be completed and delivered in the envelope provided not later than 17th JULY, 1939.

W. J. MERRETT,
County Engineer, Surveyor and Architect.

County Surveyor's Office,
43, Old Elvet,
Durham.
27th June, 1939

IMPORTANT NOTICE.

DO NOT ENCLOSE ORIGINAL TESTIMONIALS, DRAWINGS OR PHOTOS WHEN REPLYING TO ADVERTISEMENTS.

All advertisements are subject to the approval of the Proprietors. The Proprietors reserve the right to decline or omit at any time.

APPOINTMENTS & SITUATIONS OPEN

Six lines or under 4s 6d., each additional line 6d.

ARCHITECT'S ASSISTANT Required (London), experienced in commercial buildings; also JUNIOR ASSISTANT.—Write, giving full particulars, salary required, experience, and when disengaged.—Box 121, Office of "The Builder."

ASSISTANT Required, age 24 to 50, capable of preparing working drawings and details.—Apply, stating age, experience and salary required, to LEED, 21, Beaumont-street, Oxford.

ARCHITECTURAL ASSISTANT Required in busy West End Office. Factory and housing work. Salary £4 per week.—Write, stating age, experience.—Box 502, Office of "The Builder."

JUNIOR ARCHITECTURAL ASSISTANT Wanted, age about 22-24, for large Industrial Company. Surveys, levelling, working and detail drawings. State salary required and when free.—Box 499, Office of "The Builder."

ARCHITECTURAL ASSISTANT Required, preference being given to candidates with training in Architectural Draughtsmanship.

Applicants please state age, experience, and salary required, to BIRMINGHAM CO-OPERATIVE SOCIETY, Ltd., Building Dept., Woodcock-street, Birmingham.

Envelopes to be marked in left-hand corner, "Architectural Assistant."

WANTED.—DRAUGHTSMEN for Precast Concrete Works. Used to ¼in. scale plans. Taking off quantities and clerical work. State salary.—Box 468, Office of "The Builder."

MEASURING SURVEYOR Required by a large Public Works Firm in South Wales. Must be experienced in all branches of building measurement. Permanency with advancement to suitable applicant.—Reply, stating experience, salary, reference, etc., Box 467, Office of "The Builder."

LONDON Building and Public Works Contractors Require the Services of a MEASURING SURVEYOR, age between 26 and 30 years. The position is permanent and progressive. Applicant must have good knowledge of site measuring and taking off from drawings.—Reply to Box 470, Office of "The Builder," stating in confidence where presently employed, age, and salary expected

SURVEYOR - ESTIMATOR. Excellent chance for progressive young Man with initiative, who is keen and willing to relieve Principal (in old-established Firm) in estimating, quantity surveying, measuring work in progress and final accounts.—Apply, stating qualifications, copies of recent references, age, remuneration required, photograph if possible, stamped addressed envelope, J. YOUNGS & SON, Ltd., 24, City-road, Norwich.

BUILDER'S ESTIMATOR and SURVEYOR Required. Must be experienced in preparing estimates and settling final accounts for large contracts, quarter of a million and over. The position is at the Company's Head Office and permanent to a suitable applicant. Age should not exceed 45.—Apply in writing, giving full particulars of experience, names of present and recent employers, and salary required, to Box 475, Office of "The Builder."

BUILDING CONTRACTORS Require competent young SURVEYOR for measuring up, settling accounts, etc.—State age, experience, and salary required, to Box 461, Office of "The Builder."

BUILDING Contractors Require SURVEYORS to prepare final accounts on large building contract in South Wales.—Particulars and salary, Box 491, Strand House, London, W.C.2.

BUILDER'S ESTIMATOR and SURVEYOR Wanted by old-established Firm, Coastal Town. Must be practical, capable of taking off quantities, pricing, superintending, and final accounts. Age 45-50. Permanent position to suitable man.—Write, stating age, experience, and salary required, Box 481, Office of "The Builder."

SURVEYOR and ESTIMATOR Required for London. Thoroughly reliable and experienced in quantities and pricing.—Write, stating age, training, qualifications, experience, and salary required, to Box 485, Office of "The Builder."

BUILDER'S MEASURING SURVEYOR Wanted for large Government Contract near Reading.—Write, stating age, experience, and salary required, to HENRY BOOT & SONS, Ltd., 10, The Boltons, S.W.10.

FOUNDED 1882

CLERKS OF WORKS ASSOCIATION INCORPORATED 1903

ARCHITECTS SURVEYORS AND ENGINEERS Requiring CLERKS OF WORKS Are invited to apply to THE SECRETARY

CARPENTERS HALL THROGMORTON AVE., E.C.2

Applications for membership are welcomed from qualified Clerks of Works.

W. J. ALLISON
17 DAYSBROOK ROAD
S.W.2
Phone TULSE HILL 4361

BUILDER'S MEASURING SURVEYOR Required for contract work. Progressive position. Must be thoroughly experienced in dealing with all trades and measuring on site.—Age, experience and salary to Box 497, Office of "The Builder."

PLUMBING SURVEYOR, experienced measuring, abstracting, billing, Required for West End Offices of large London Firm. Only experienced men need apply. State age, experience, salary required.—Box 501, Office of "The Builder."

JUNIOR SURVEYOR Required immediately, good at figures and experienced in squaring and abstracting. Would be required in first instance to assist Surveyors on Government Contract, Aldershot district.—Apply by letter, stating age, experience, and salary required, to KIRK & KIRK, Ltd., Atlas Works, Putney, S.W.15.

WANTED.—SENIOR ASSISTANT or QUANTITY SURVEYOR for quantity side of busy provincial Architect's and Surveyor's Office. Must be capable of taking off and billing to standard method and preparing final accounts. P.A.S.I. preferred. A good job is offered to the right man.—Apply, with full particulars and references, to Box 472, Office of "The Builder."

ASSISTANT Required (22-25). Experienced measurements, quantities, general office routine, wages, etc. Good typing and some experience with painting contracts an advantage.—State wages, experience, etc., to SERVICE MANAGER, Box 482, Office of "The Builder."

SURVEYOR, South Coast, seeks ASSISTANT with experience in supervision of building works. Must be capable of survey of site, setting out and supervising building works in progress, measurement of variations and settlement of builders' accounts.—Write, giving age, full particulars of experience, and salary required, to Box 487, Office of "The Builder."

SURVEYOR'S ASSISTANT and WORKER-UP Wanted by London Contractor for important Government Contract in South Lancashire.—Write, stating age, full particulars of experience, and salary required, Box 117, Office of "The Builder."

WANTED.—Young MAN or LADY with some experience of estimating, quantities and measurements in engineering and building work.—Write, stating age, experience, and salary required, to Box 463, Office of "The Builder."

QUANTITY SURVEYORS.—TAKER-OFF and WORKER-UP Required. Must be thoroughly competent. Permanencies. Age, qualifications, when disengaged, and salary required, to HAUGHTON, SON & HOOKWAY, 34-35, Bedford-street, Plymouth.

WORKER-UP Required in London Quantity Surveyor's office, with opportunities for advancement. Only those with first-class experience will be considered.—State age, experience, and salary required, to Box 114, Office of "The Builder."

COMPETENT WORKER-UP Required for London Quantity Surveyor's Office. Must be experienced in large works.—Write, stating age, qualifications, and salary required, to Box 520, Office of "The Builder."

MEASURING CLERK and COST CLERK Required by Firm of Plastering Contractors with Offices in London.—Apply, stating age, salary and experience, to Box 479, Office of "The Builder."

BUILDER'S ESTIMATOR Required for London office. Fully competent to carry out whole of estimator's duties.—All particulars to Box 465, Office of "The Builder."

BUILDER'S ESTIMATING CLERK (for Slough area), competent to prepare and price bills of quantities and measure up and prepare variation bills. Salary £6 per week.—Applications, stating age and qualifications, accompanied by copies of not more than three testimonials, to Box 460, Office of "The Builder."

EXPERIENCED ESTIMATING CLERK Required by old-established Firm of Builders, Bristol.—Apply, giving full particulars, Box 478, Office of "The Builder."

EXPERIENCED ESTIMATOR Required, age 30-40. Permanent progressive post.—Apply, giving qualifications and salary, etc., to Box 518, Office of "The Builder."

CLERK OF WORKS Required by a Metropolitan Borough Council in connection with the erection of a Municipal Building to cost approximately £40,000. Wages up to £8 8s. per week.—Reply, stating age, experience, etc., together with copies of three testimonials, not later than 12 noon, 10th JULY, 1939, to Box No. 598, c/o WHITES, Ltd., 72, Fleet-street, E.C.4.

REQUIRED.—A MANAGER for old-established Decorators' Business in West London. Owner retiring. Must have similar experience. Age 35-40.—Box 104, Office of "The Builder."

BUILDER'S MANAGER Required in branch office in West Midland town. Must be used to first-class work only, have knowledge of estimating and surveying in connection with variations, have thorough knowledge of all trades, be good organiser, and able to drive car to supervise jobs at a distance as may be required. Only men of ability need apply.—Send particulars of age, experience, salary required, and copies of testimonials, to Box 517, Office of "The Builder."

BUILDER'S GENERAL FOREMAN Required for job, Millwall. Must be thoroughly competent, including experience in reinforced concrete. State age and wage.—Apply, Box 516, Office of "The Builder."

FOREMAN Required for Warehouse Extension.—Write, giving full particulars, to SOUTH-EASTERN CONTRACTORS, 91, Rosendale-road, W. Dulwich, S.E.21.

FOREMAN Required for Joinery Dept. of Country Builders and Contractors. Must be first-class organiser and able to turn out work at low costs. Knowledge of modern machinery essential.—Reply, stating age, experience, wages required, and references, to Box 101, Office of "The Builder."

GENERAL FOREMAN Required for large War Office Contract in Midlands. Must be fully competent and understand W.O. schedule; able to carry job through.—Full particulars, Box 102, Office of "The Builder."

GENERAL FOREMAN (first-class) Required for large municipal contract in N. London.—Applications must be in writing only, stating age, salary required, and three recent references, to THE RAGLAN BUILDING CO., Ltd., Forty-lane, Wembley Park.

SALES MANAGER Required by Manufacturers of Bituminous and Chemical products for the Building Trade. Must have proof of connections amongst architects, builders, contractors, etc. Good salary and bonus.—Apply, Box 503, Office of "The Builder."

OLD-ESTABLISHED Cast-Stone Manufacturers Require REPRESENTATION in Guildford, Tunbridge Wells, Winchester, Salisbury, Reading, Oxford, Aylesbury, Bedford, Cambridge. Agent must have first-class connection with Architects.—Apply, Box 471, Office of "The Builder."

FIRST-CLASS SALESMAN and CONTACT MAN Required, with good connections, for Joinery Manufacturing Concern, West London. Strict confidence will be observed.—Reply, giving brief but full particulars, to Box 484, Office of "The Builder."

AGENT Required for large Government Contract in Berkshire. Only first-class man with successful experience on similar contracts need apply.—Reply, giving full details and salary required, to Box 492, Office of "The Builder."

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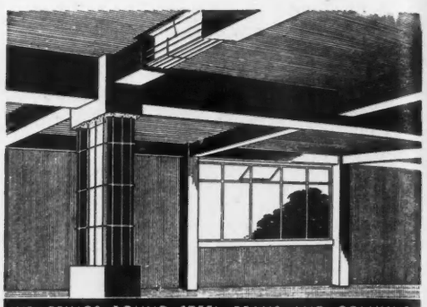

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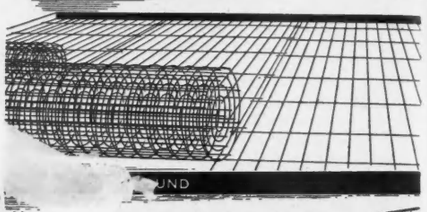

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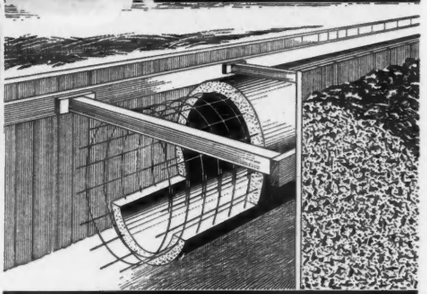

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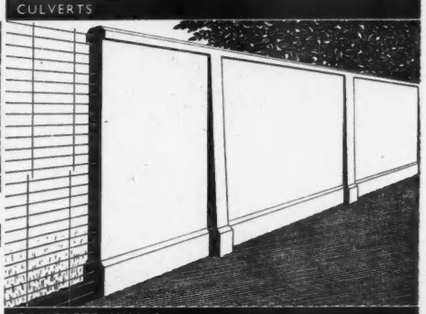

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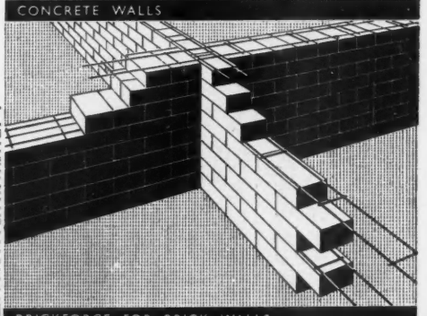

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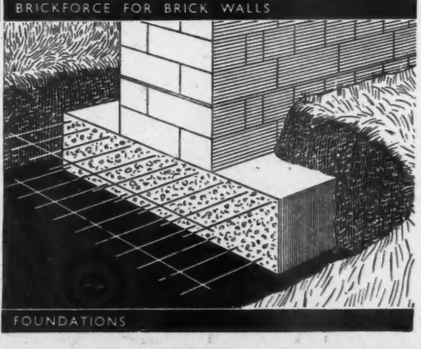

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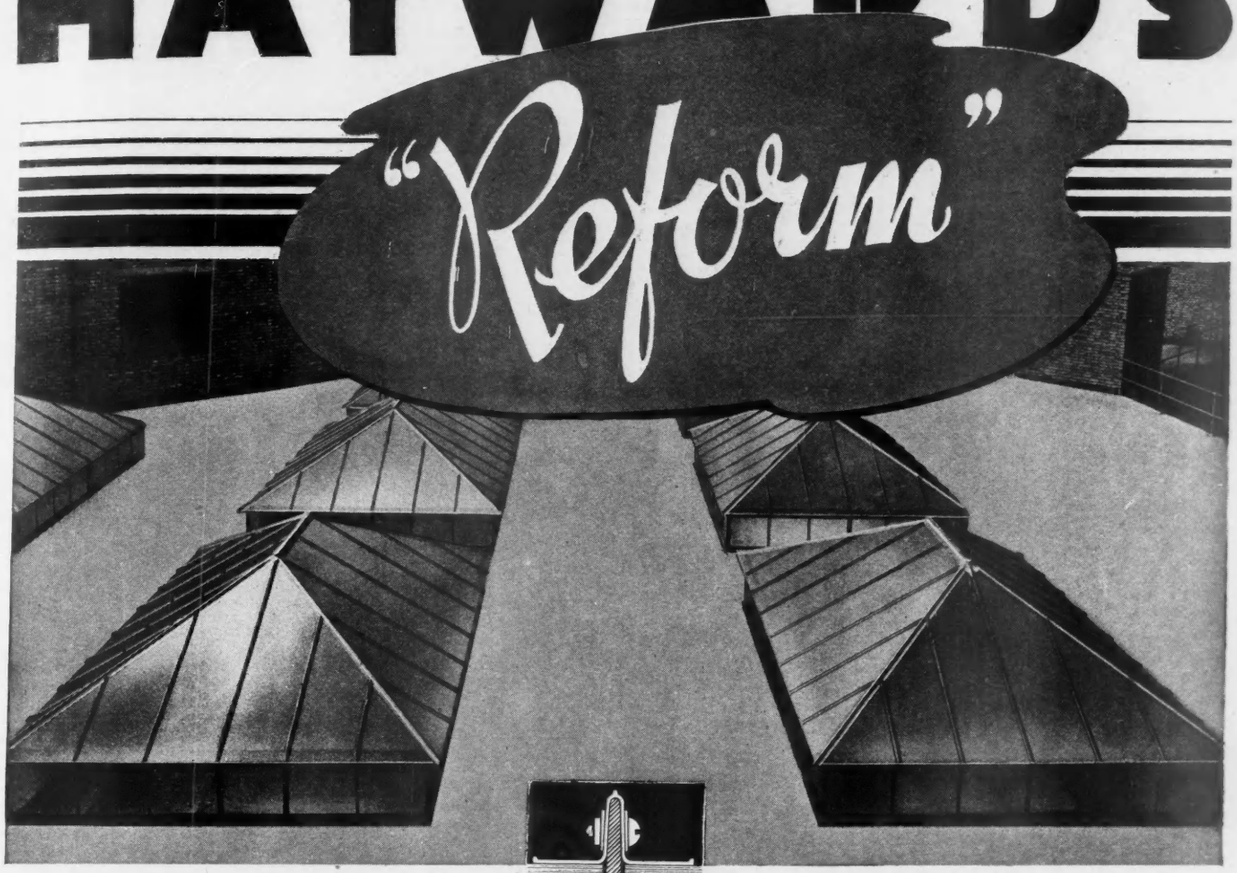

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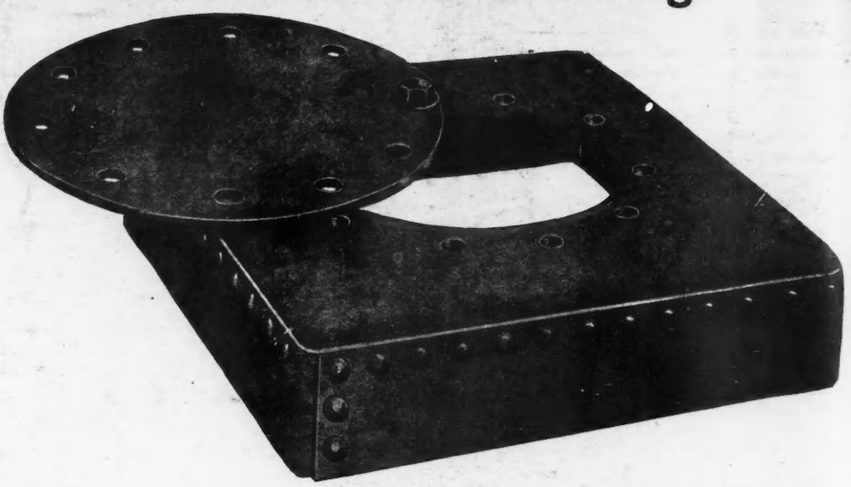

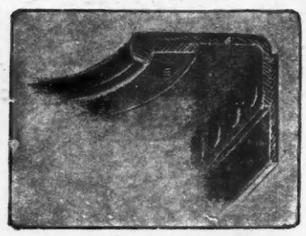

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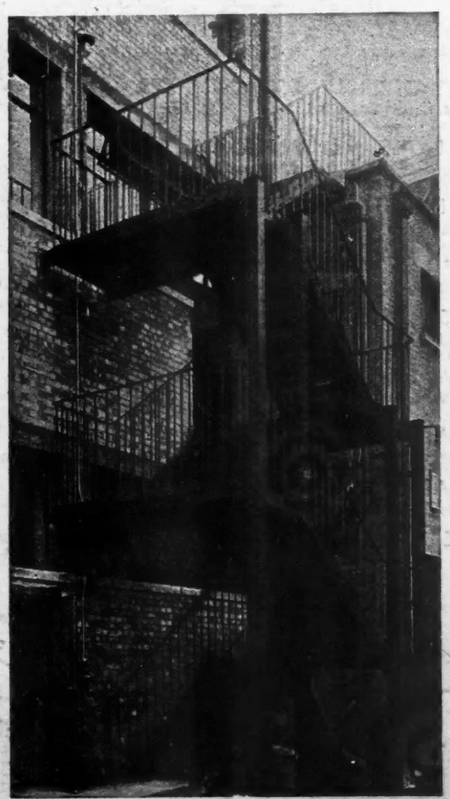

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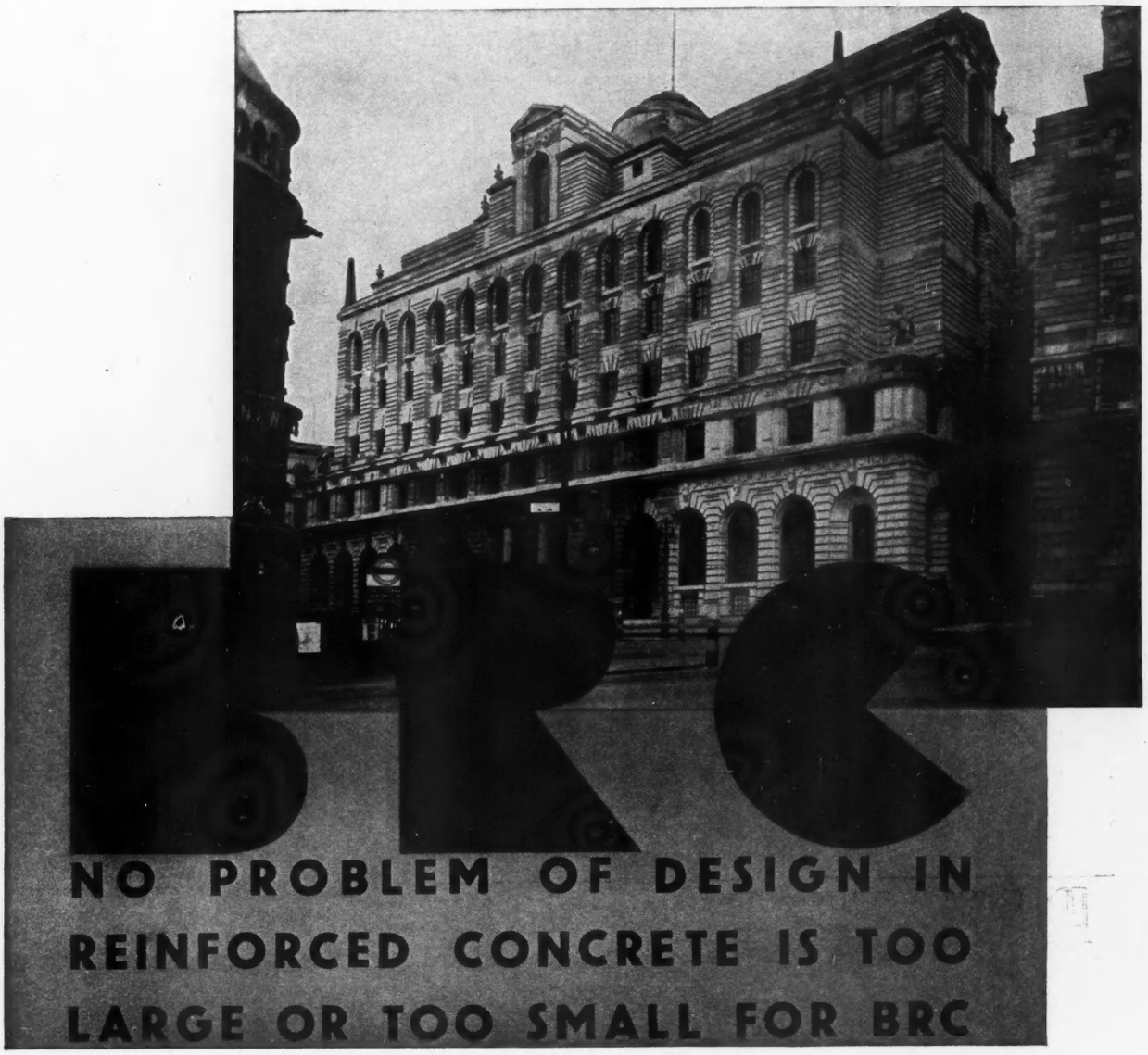

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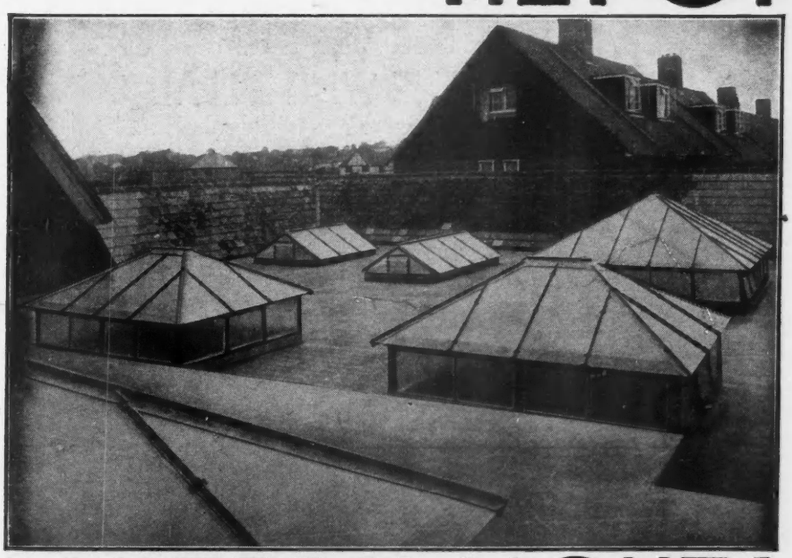

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